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INSTRUMENTS

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Devoted to Measurement and Control Problems

Vol. 4. No. 5 Pittsburgh, Pa. May, 1931

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New Instruments

- New Snap Case-Front Industrial Thermometer
- New Wet and Dry Bulb Thermometer Fixture
- New Power Type Pressure Device
- Thread Checking Gage
- The Howe Weightograph
- Indicator With Free-Rotating Drum for Taking Time Diagrams
- Indicator With Initial-Tension
- Constancy Test for Photo Tubes
- Motor Driven Weight Car
- Sauter Electric Time Switch
- Electric Eye Sees Paper Break and Stops Printing Press
- Universal High-Voltage Testing Set
- Oil-Immersed Thermaload Starter
- Printing Press Controller

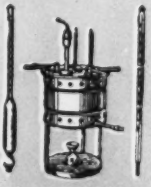
Place initials of interested persons in your organization opposite title and call it to their attention.

RECORDING THERMOMETERS AND PRESSURE GAGES

RECORDER - CONTROLLERS

AUTOMATIC CONTROLLERS

DIAL - INDICATING THERMOMETERS



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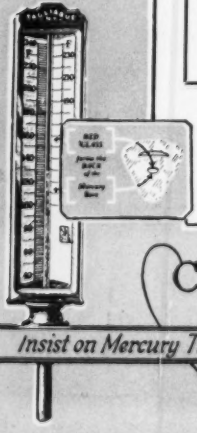
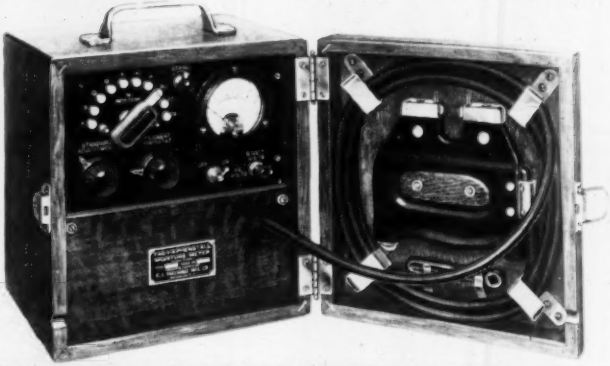


PRICE REDUCTION



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NEW

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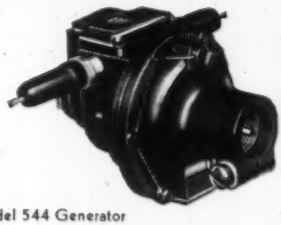

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It has already met with instant acceptance in the motor boat and aviation fields where speed indicators must be unusually rugged, dependable, and trouble-free — yet light and compact.

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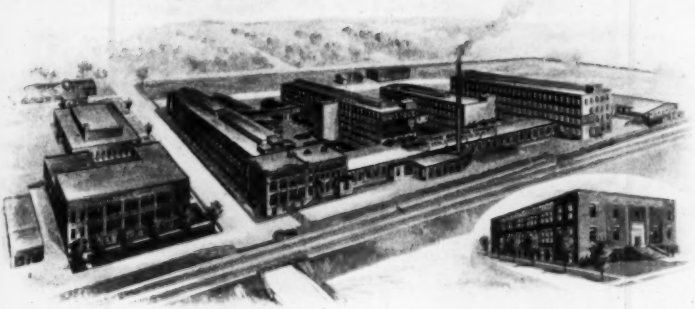

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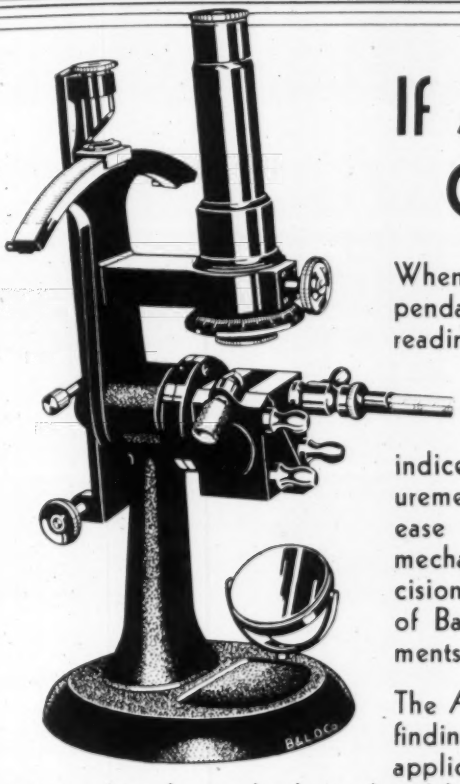

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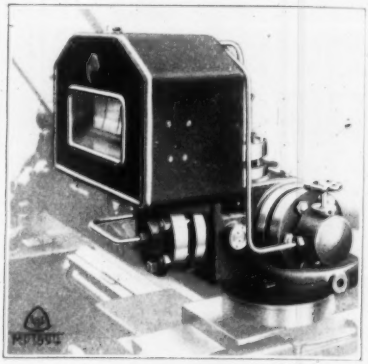
The LATHE TOOL DYNAMOMETER



for determining and charting the vertical, horizontal and axial tool pressures for studies of tool hardness, grinding angles and angles of attack of tools, life of cutting edge, lubricants, machinability of metals and time studies for piece work.

Similar apparatus made for drills, shapers, planers and milling machines.

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Here is a Pyrometer that can be mounted on the oven or furnace where it can be seen at all times and read at a glance.

Priced low enough for use alone or to supplement other pyrometer equipment.

It will save time, labor, fuel and will aid in in better temperature control.

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Niagara Meters measure any liquid not chemically destructive. Use them for accurate automatic measurement in place of gaugesticks, measuring tanks and other makeshift means. Eliminate exposure of liquids to contamination and fire hazard. Also for accurate keeping of cost and inventory records. Send for complete information.

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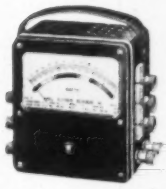
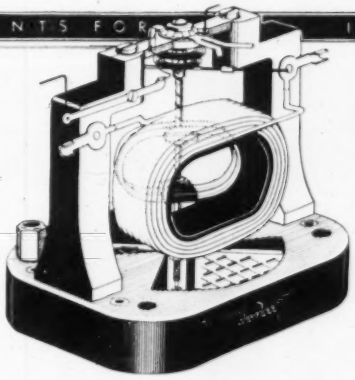
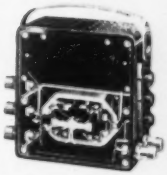
INSTRUMENTS FOR INDUSTRY



The remarkably large scale opening enclosed with non - shatterable glass makes it easy to read Jewell Master Instruments.





The Style L Dynamometer movement is mounted in a dust tight, bakelite case with resistances in a separate ventilated compartment.

The STYLE L MOVEMENT

in Master Portable Wattmeters is a triumph of instrument design

JEWELL

MASTER INSTRUMENTS

Pattern 170— Current Transformer
Pattern 171— D. C. Voltmeter or Ammeter
Pattern 172— A. C. Voltmeter or Ammeter
Pattern 173— Single Phase Wattmeter
Pattern 174— VoltAmp Wattmeter
Pattern 175— Polyphase Wattmeter
Pattern 176— Thermal Voltmeter

Tucked away in the case of the Jewell Master Portable Wattmeter is the Jewell Style L Dynamometer Movement, recognized universally as a triumph of instrument design!

It is easy to become enthusiastic about the Jewell Dynamometer Movement. This sensitive but amazingly rugged unit has made possible single and polyphase wattmeters that maintain their high accuracy in spite of the hard treatment which they receive in portable testing service.

There are many unusual refinements, such as the extensive use of molded bakelite for fan boxes, supporting pillars, coil supports, and covers. Magnetic shields prevent external fields from affecting the instruments. The moving element with its double aluminum damper fans is "dead beat."

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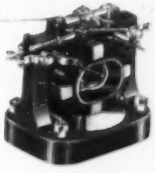
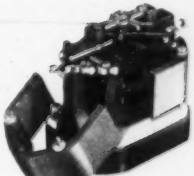


The series coils are wound in two sections to provide double current ranges.

LEATHER CARRYING CASES

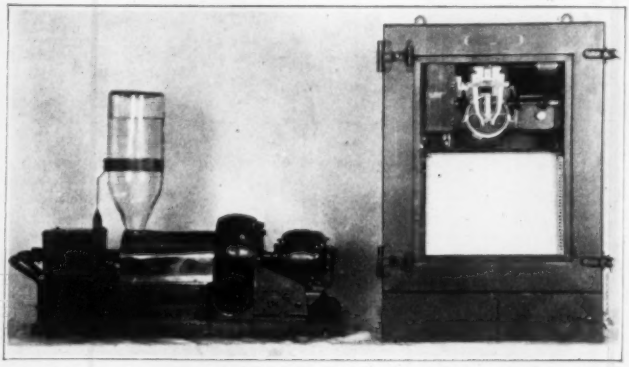
The uniform dimensions of Master Portable Instruments make for utmost convenience. Sole leather carrying cases can be furnished with 1, 2, 3 and 4 instrument compartments.



The magnetic shield excludes interference from stray magnetic fields.

When writing to the above company, please mention INSTRUMENTS

A Direct Reading Relative Humidity Recorder



Wetting Device and Humidity Recorder in Special Vapor-Proof Cabinet. Instrument shows relative humidity in per cent, without calculation.

This equipment makes a continuous record of relative humidity on a chart 9⅞ inches wide, calibrated from 20 to 100 per cent relative humidity. Within the temperature range from 32 degrees F. to 175 degrees F. it is sensitive to a change of 0.5 per cent relative humidity and the limit of error is 1.5 per cent relative humidity. The apparatus is particularly suitable for use with air conditioning equipment in textile mills, paper mills, tobacco storage and conditioning rooms, lithographing and printing plants and constant humidity test rooms.

The equipment consists, as shown above, of an L & N Recorder and a device for supplying to a wet-bulb electrical resistance thermometer a current of the air to be measured. Provision is of course made for supporting the dry-bulb thermometer near the wet bulb. The thermometers can be located at any distance from the Recorder.

8800 AI Relative Humidity Recorder Equipment $582 50

Includes: One 8800 Humidity Recorder, one 8172 Wetting Device, one 8147 Pair Resistance Thermometers, one 8148-10 Pair Calibrated Leads 10 feet long, (longer leads can be furnished at slight extra cost). Vapor-Proof Cabinet $85.00 extra.

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Richard Rimbach, Managing Editor **M. F. Béhar**, Engineering Editor

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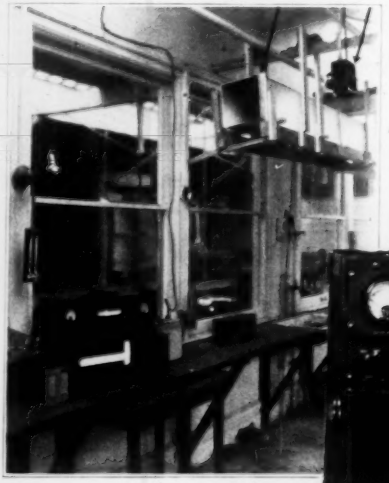
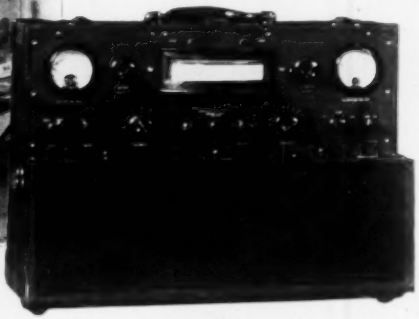
STUDY YOUR NOISE and VIBRATION PROBLEMS with the NEW BURGESS ACOUSTIMETER



Left: Note air duct and microphone are shown by arrows. Wires from microphone carry sounds to acoustimeter where they are measured.



THE Burgess Acoustimeter is helping engineers and designers to eliminate noise from their products, by providing a direct, scientific method for the measurement of sound intensity. The photograph shows the Acoustimeter being used to study the noise in ventilating ducts, thereby providing an accurate means for determining the effect of changes in design.

The Burgess Acoustimeter will help you to quiet your equipment. Write for descriptive literature.

BURGESS-PARR COMPANY
DIVISION OF C. F. BURGESS LABORATORIES INC.
111 WEST MONROE STREET
CHICAGO, ILLINOIS

EDITORIAL COMMENT

The First Instrument Show

THE exhibit of testing apparatus and machines to be held in Chicago in conjunction with the 34th annual meeting of the American Society for Testing Materials, June 22 to 26, will really be the first large-scale Instrument Show. It is true that it will be limited to apparatus, equipment and machines used in the testing of materials, but testing instruments will dominate and visitors will, we believe, be saying for months, "I saw it at the Instrument Show at Chicago. It works this way . . ."

The moment we were notified by the Society, we pledged our wholehearted assistance. We just had time to announce this event in our last issue; further details appear here and our next issue will contain a special section devoted to the worthy Society and to its commendable exposition. While refraining from doing anything that would savor of sensationalism, we are determined that none of our readers will fail to be properly impressed with the aims and scope of this historic undertaking. *Instruments* has no connection with the A.S.T.M. but we believe it to be the duty of *Instruments* to do all in its power in connection with this project.

The thousands of our readers who are not members of the A.S.T.M. will find in our next issue for their convenience the program, the floor plan, the list of exhibitors, what they will exhibit, etc.

We are reminded of the important and lasting effects of the Special Calorimetry Issue we published in February of last year. Our June 1931 issue will be a Special Testing Instrument Issue. Therefore even the members of the Society will find our next issue of distinct interest to them—which is as it should be, for if our plans did not contemplate doing something for them, we would not be fulfilling our mission.

Inasmuch as many of the visitors to the Exposition will be interested not only in testing apparatus but in instruments of classes excluded from the Show, we have reserved a booth at which we will maintain a general Instrument Information Service. The Society has accepted our offer and assigned us to Booth No. 25, where we shall be glad to answer questions pertaining to instruments, etc. Engineers who become interested in the remarkable progress recently made in testing some certain property or condition, can later come to *Instruments'* booth to get a line on the means available for continuously *indicating* such a property or condition in industrial plants, for *recording* it, and for *controlling* it automatically. One thing, however, is certain: there will not be a single piece of commercial literature in the *Instruments'* booth. Another thing is certain: questions will be put regarding instruments which have not yet made their appearance on the market. We hope that there will be many such questions: a tabulation may then be published in a subsequent issue of *Instruments*, to point out some definite directions that should be taken by inventors and instrument firms.

All in all, we are very enthusiastic about the first Instrument Show. We congratulate that little executive group in the A.S.T.M. who are responsible for it; and to all those of our readers who are interested in testing, we say,

"See you at the Show at Chicago on June 22!"

Keep Up With Progress

"TREMENDOUS" is an adjective that seldom justifies employment, but the use of a weaker qualification for the present growth of Instrumentation would fall short of conveying the truth. The point has been reached where an engineer's entire time is insufficient to assimilate thoroughly all the current advances in industrial Instrumentation. Similarly, a trained physicist studying eight hours a day could not thoroughly absorb all of the current developments in the field of scientific instruments. Every day there appear throughout the world developments of interest to each and every industrial or scientific reader of *Instruments*. Every month brings forth hundreds of new ideas, new applications and new methods, in addition to a comparatively smaller number of new commercial instruments. Our illustrated New Instruments Section is deservedly scanned attentively, and needs no recommendation. Our Manufacturers' Literature Section is also scrutinized eagerly, mostly by prospective buyers. The purpose of this editorial is to point out the equal or even greater practical value of our Current Literature Review Section. Those of our readers who systematically study this Section derive great benefits. The others have a treat in store for them, because those pages are painstakingly prepared *especially for instrument users*.

We know full well that abstracts of many papers and articles are prepared by their authors or by the publications where they appear, but these published summaries fail to tell instrument users about the many gems of practical information regarding Instrumentation which so many current articles contain. Our abstract editors, on the other hand, without disregarding official summaries, nevertheless laboriously "dig for gold" with only the needs of our readers in mind.

True, there are other review and digest services, but only ours employs a well-balanced team of reporters whose business it is to find all items of interest to instrument users, including many instrument items which are quite concealed by the titles of the articles in which they appear.

Example: An excellent illustrated discussion of good and bad thermocouple welds. This discussion appeared in a paper on "The Heat Balance," published in the *Transactions* of the A.S.M.E.

Another example: A highly practical discussion of viscosity determinations, in a paper entitled, "Classifying Transmission and Rear Axle Lubricants," in the S.A.E. *Journal*.

The first is of vital interest to anyone concerned with the measurement of gas temperatures, or with pyrometric practice in general; the second deserves study not only by automotive men but by a host of other engineers, chemists, lubricating engineers, experimental physicists, etc.

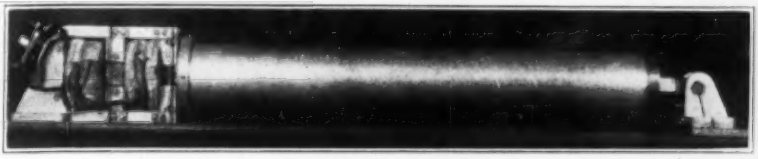
In each case, ninety-nine percent of these interested in each discussion are not readers of either publication and would not learn of the discussion if it were not for the Current Literature Review Section of *Instruments*.

As a reader of *Instruments* you are vitally interested in at least one field of measurement or automatic control. You must realize that throughout the world you have a number of colleagues and co-laborers, among whom are men who are not merely sitting back but doing things. These things are being reported. You haven't the time to read thousands of technical and scientific journals and it may have seemed hopelessly difficult for you to keep up with the procession. It no longer is difficult: the Current Literature Review makes it easy. Use it!

An Impact Strain Gage*

Dr. Clarence Alois Andree**

THE tendency toward higher pressures and higher velocities in machinery of all kinds has made the problem of determining the instantaneous variation in strain from some normal value a matter of increasing importance. The phase of this problem for which the following apparatus was designed was the determination of strains in railway bridge members. However, it will be obvious that with slight modifications the apparatus may be applied to other problems involving a knowledge of instantaneous variations in distance or in force.



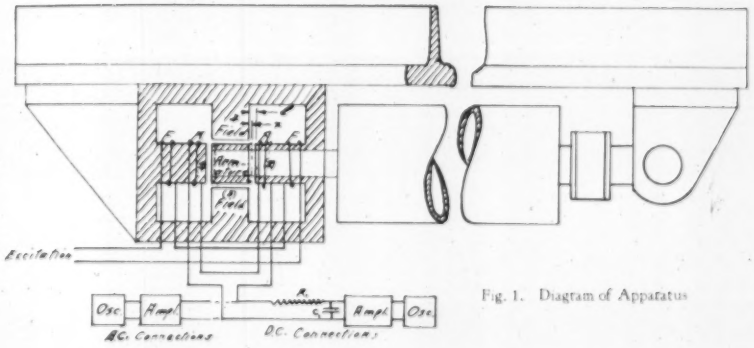


Fig. 1. Diagram of Apparatus

The device consists of a laminated iron field core and armature. The armature is located at the center of 4 field poles, thus producing the 4 air gaps 1, 2, 3, 4, (Fig. 1). The flux is produced by 2 field coils connected in series in such a manner that a field current produces like poles at gaps 1 and 2. Opposite poles result at the lateral gaps 3 and 4, which merely provide for free motion of the armature. A motion of the armature varies the length of gaps 1 and 2 and thereby increases the flux through one pole and decreases it through the other. The 2 armature coils on poles 1 and 2 are connected in series in such a manner that the 2 voltages induced in them will aid each other.

*Thesis submitted for the degree of Doctor of Philosophy.

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NOTATION

μ The permeability of free space $0.4\pi\times10^{-8}$.
A Effective cross section of the air gap.
l Fig. 2b length of air gap when the armature is in its mid position.
l_1, l_2, l_3 Normal lengths of air gaps, 1, 2, 3 respectively.
$\mathcal{N}_F$ Number of turns in one field coil.
$\mathcal{N}_a$ Number of turns in one armature coil.
x Instantaneous displacements of the armature from its normal position.
X_m Maximum armature displacement.
ϕ_1, ϕ_2, ϕ_3 The magnetic flux through gaps 1, 2, 3 respectively.
R_1 Total series resistance of armature circuit when connected for D. C. excitation.
L_1 Inductance of armature coils.
C_1 Capacitance in series with R_1 and L_1.
w Angular velocity of armature displacements.
w_o Angular velocity of alternating field currents.
K A constant whose value depends only upon the design of the recorder.
K_A Proportionality constant between the voltage impressed on the amplifier and the deflection of the oscillograph.
M Calibrating mutual inductance A. C. excitation.
C_2 Calibrating condenser D. C. excitation.
R_2 Calibrating resistance D. C. excitation.
S_M Dial readings of the calibrating mutual inductance.
S_R Dial readings of the calibrating resistance.
i Field current (either direct or alternating).
I_a Maximum value of field current (A. C. excitation).
I_D Value of field current (D. C. excitation).
I Vector magnitude of armature current (D. C. excitation).
e Armature voltage (either direct or alternating).
E Vector magnitude of armature voltage (D. C. excitation).
E_m Maximum value of armature voltage (A. C. excitation).
E_R Deviations in E_m from some normal value (A. C. excitation).
E_R Voltage across amplifier after integrating armature coil voltage. (D. C. excitation).
e_c Voltage across amplifier input from calibrating mutual (A. C. excitation).
E_c Peak voltage across amplifier input from calibrating mutual (A. C. excitation).
E_c Peak voltage across amplifier input from calibrating condenser (D. C. excitation).
d_R Oscillograph deflections resulting from recorder voltages (A. C. or D. C. excitation).
d_c Oscillograph deflections resulting from calibrating voltages (A. C. or D. C. excitation).

THE THEORY UNDERLYING THE RECORDER

If we neglect leakage flux and assume the total reluctance to be concentrated in the air gaps, we shall have for ϕ_1 and ϕ_2, the fluxes in gaps 1 and 2 respectively:

$$\phi_1 = \frac{\mu A \mathcal{N} \rho i (l_2 + x)}{[l_1 l_2 + l_3(l_1 + l_2)] - [(l_2 - l_1)x + x_2]} \quad (1)^*$$

$$\phi_2 = \frac{\mu A \mathcal{N} \rho i (l_1 - x)}{[l_1 l_2 + l_3(l_1 + l_2)] - [(l_2 - l_1)x + x_2]} \quad (2)$$

Now it will be desirable to have the variation in ϕ_1 and ϕ_2 proportional to x. This will require that the term $[(l_2-l_1)x+x^2]$ be small compared with the term $[l_1l_2+l_3(l_1+l_2)]$. This requires that the armature be centered in the air gap and that x^2 be small compared with l_1l_2 or l^2. The error increases as the square of x and is about 1% for $x=0.1l$.

The exciting current, i, appearing in equations (1) and (2) may be either a direct or an alternating current. The connections between the recording device and the armature coils are different for the different excitations and are shown in the diagram of Fig. 1.

*The system of units here used is the "Practical" or "C.G.S.S." system. (Ref. Introductory Electrodynamics for Engineers by E. Bennett and H. M. Crothers.) In this system, μ the permeability of free space, is set equals to $0.4\pi10^{-8}$, the unit of magnetomotive force is the ampere turn; and the unit of flux is the weber which equals 10^8 maxwells.

In general direct current excitation will be desirable for recording frequencies above 30 cycles/second; whereas; an alternating current of 600 cycles will be desirable for recording frequencies below 60 cycles.

If now we assume a sinusoidal variation of exciting current of frequency w_0 and a sinusoidal variation of armature displacement of frequency w and of phase displacement d, we shall have for the sum of the voltages induced in the 2 armature coils

$$e = \frac{2\mu\, AN_aN_F}{l_1l_2+l_3(l_1+l_2)}\left[x\, I_a w_o \cos w_o t + \left(\frac{l_2-l_1}{2}\right) I_a\, w_o \cos w_o t + ix_m\, w \cos(wt+d)\right] \quad (3)$$

In the above expression there are 3 terms within the square brackets. In the first of these terms the amplitude is proportional to x. This term is therefore desirable. The second term has a constant amplitude. The deflections above or below this constant amplitude which result from the first term record the armature displacements. The third term is not proportional to x. The deflections from this term if added to the first term upset the nice proportionality which otherwise makes the determination of x a simple matter. The third term is therefore undesirable and should be kept small. It may be shown that this term may be neglected compared with the first term provided w^2 may be neglected in comparison with w_0^2. This approximation will hold within 1% if $w \geq 0.1\, w_0$. The record of x may be obtained from equation (3) by dropping the third term and considering only the values when $\cos w_0 t = \pm 1$. The values which form the envelope of this curve are

$$E_m = \pm\left(x+\frac{(l_2-l_1)}{2}\right)K\, I_A w \quad (4)$$

$$where\ K = \frac{2\mu\, AN_aN_F}{l_1l_2+l_3(l_1+l_2)} \quad (5)$$

Now if E_R represents the deviation of E_m from the constant value $K\, I_A\, w_o\left(\frac{l_2-l_1}{2}\right)$, we have

$$E_R = K\, I_A w_o\, x. \quad (6)$$

Since K, I_A, and w_0 are all constants, E_R is seen to be proportional to x.

The curve labelled "Armature Deflection Record" in Fig. 2, shows a record made with this type of excitation.

If the alternating excitation which we have been considering is replaced by direct current excitation, the recording circuit must be altered by the introduction of an integrating circuit. This circuit consists of the resistance, R_1, and condenser, C_1, as shown by the "D-C connections" in Fig. 1. The reason for the introduction of the integrating circuit is at once apparent when we consider that the flux as shown by equations 1 and 2 is proportional to the displacement x, but that the voltage induced in the armature coils by this flux is proportional to the derivative of the flux. If now this voltage be integrated, the resultant voltage will again be proportional to the flux and therefore to the displacement x.

Let E represent the voltage induced in the armature coils, then if we adopt the complete notation the resultant current I, for direct excitation will be

$$I = \frac{E}{R_1+jwL_1+\dfrac{1}{jwC_1}} \quad (7)$$

The impedance of the amplifier is sufficiently high so that current through it may be neglected. Now if $(wL_1)^2$ is less than $0.01R^2$ and $\left(\frac{1}{wC_1}\right)^2$ is less than $0.01R^2$, then the amplitude of I may be expressed correctly within 1% by

$$I = \frac{E}{R_1} \quad (8)$$

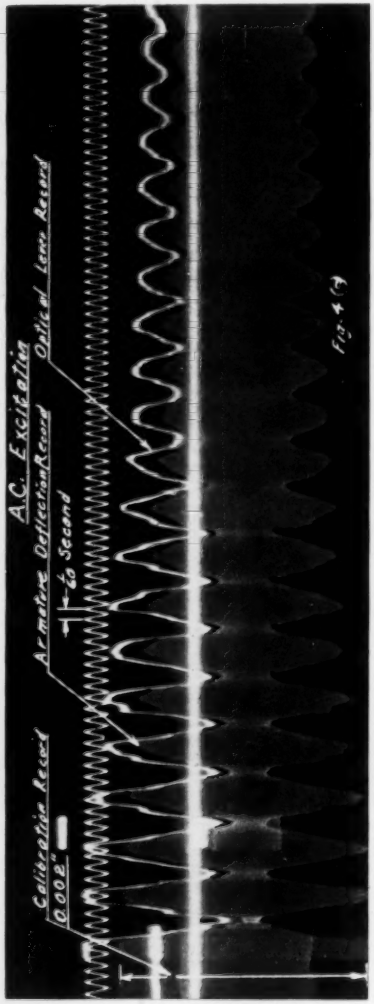


Fig. 2a

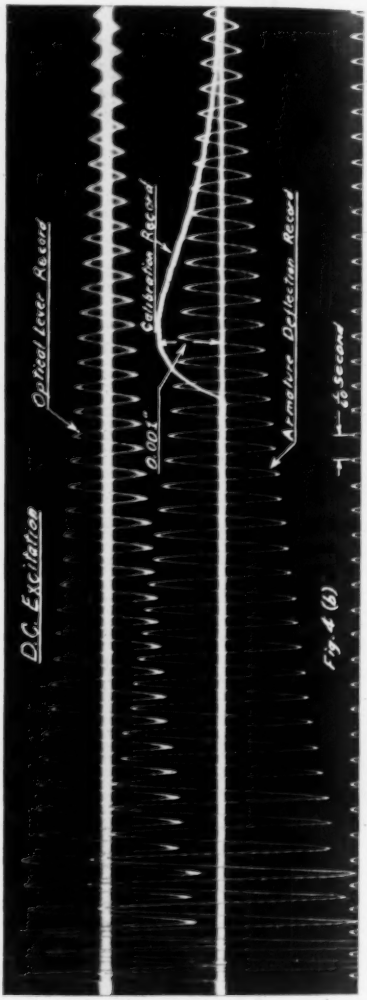


Fig. 2b

and the phase angle will differ from the correct value by an angle whose tangent is less than 0.1. Now since the voltage across the condenser, C_1, is the integral of the current, and since we have made this current proportional to the voltage induced in the armature coils, we have compensated for the fact that this induced voltage is the derivative of the flux. The condenser voltage, E_R, is then proportional to the flux and we may readily show that

$$E_R = \frac{N_A}{C_1 R_1} (\phi_1 - \phi_2) = \frac{K I_D x}{C_1 R_1} \qquad (9)$$

where K is given by equation (5).

The assumptions necessary in order to obtain equation (8) impose an upper and lower frquency limit on the apparatus. With the present apparatus these limits are 900 cycles and 30 cycles respectively. The record obtained with this type of excitation is shown in Fig. 2 and is labelled "Armature Deflection Record."

THE CALIBRATION OF THE APPARATUS WHEN THE EXCITING CURRENT IS ALTERNATING

The complete circuit used for recording and for calibrating when both A. C. and D. C. excitation are used is shown in Fig. 3. To change the method of recording from A. C. to D. C. it is only necessary to change switch (1) from the position marked A. C. to that marked D. C. Suppose that switch (1) is in the position marked A. C. When switch (2) is in the position marked "recording," the amplifier receives the voltage e directly from the armature coil. It is true that with switch 1 in this position the resistance R_1 in series with the capacity C_1 forms a shunt across the armature coils. However, the impedance of this shunt is so

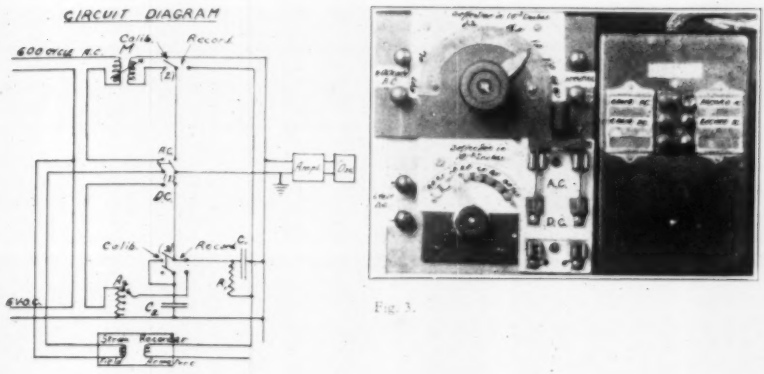


Fig. 3.

great relative to the reactance of the armature coils that the current supplied to this shunt produces no appreciable voltage drop in the armature coils. When switch 2 is in the position marked "calibration" the amplifier receives the voltage e_c from the secondary of the mutual inductance. Since the primary of this mutual inductance is in series with the field coil of the strain recorder, the current flowing through it will be

$$i = I_A \sin w_o t \text{ and the voltage } e_c \text{ will be}$$

$$e_c = MI_A w_o \cos w_o t$$

$$\text{The peak values of } e_c \text{ will be}$$

$$E_c = MI_A w_o \qquad (10)$$

Taking the ratio of the strain recorder voltage E_R (See Eq. 6) to the calibration voltage E_c we have

$$\frac{E_R}{E_c} = \frac{Kw_o x I_A}{MI_A w_o} = \frac{Kx}{M} \qquad (11)$$

If K_A represents the proportionality constant between the voltage impressed on the amplifier and the deflection of the oscillograph, we may write

$$\frac{E_R}{E_c} = \frac{K_A d_R}{K_A d_c} = \frac{d_R}{d_c} = \frac{Kx}{M}$$

or

$$x = \frac{M}{K} \quad \frac{d_R}{d_c} \qquad (12)$$

in which d_R and d_c represent the deflection on the oscillograph due to E_R and E_c respectively. We note that by this comparison method, the frequency, the magnitude of the input current and the proportionality constant representing the sensitivity of the amplifier and oscillograph have all been eliminated from the determination of x. The value of x depends only upon the constant of the apparatus, the setting of the mutual inductance M, and the ratio of 2 de-

flections on the oscillograph film. If the scale readings, S_M, of the mutual M are labelled in terms of $\frac{M}{K}$ instead of in terms of M, then x will equal the scale reading times the ratio of the 2 deflections, i.e.

$$x = S_M \frac{d_R}{d_c} \quad . \quad . \quad . \quad . \quad . \quad (13)$$

The scale readings will then represent the deflections which x will have when d_R equals d_c. The scale readings therefore may be expressed in inches or centimeters. In taking a reading the usual method of procedure is to set the mutual inductance to a scale reading that represents the maximum deflection that one expects to record and then to adjust the amplifier so that this deflection has a reasonable magnitude on the oscillograph record. A record of this deflection is made on the film and the switch is then thrown to the recording position. Now if the armature has not previously been adjusted, its initial deflection from the mid-position may greatly exceed the deflection which we desire to record and the resultant initial reading may therefore be off scale. It is generally desirable to have a sufficient shift in the initial position of the armature so that the maximum deflection resulting from an impact will cause the armature to deflect to slightly less than the mid-position. This will prevent the 2 envelopes of the curve from crossing. (This is illustrated in the curve labeled "Armature Deflection Record" of Fig. 2a. The initial position of the armature has been adjusted so that under the influences of the largest deflection, as shown at the left of the record, the two envelopes do not quite cross.) To give the armature this deflection (it is assumed that the maximum deflection may be estimated before the record is taken) the calibrated mutual is set to this scale reading. The secondary coil of this mutual is then connected directly to the armature coil of the strain recorder by a special setting of switch — (not shown on the circuit diagram). With this setting the 2 coils will be connected in series so that the 2 voltages oppose. The armature is then moved until the 2 voltages balance. This balance point may be conveniently determined by inserting a headphone in series with the armature coil and adjusting the armature until the signal in the headphone is a minimum. The equipment is then ready for recording.

THE CALIBRATION OF THE APPARATUS WHEN THE EXCITING CURRENT IS DIRECT

Suppose now that switch 1, Fig. 3, is in the position marked D. C. and that switch 3 is in the recording position. C_2 will then be charged to some voltage depending on the setting of the dial on R_2. If switch 3 is now thrown to the calibration position, there will result a transient voltage across the amplifier terminals. Since R_1 is quite large, the circuit is critically damped. The voltage across the amplifier rises almost instantly and then rapidly decays. When the switch is closed a redistribution of charge occurs between C_1 and C_2. This occurs practically instantaneously and the peak voltage of the transient that is recorded is the result of this redistribution of charge. The peak value E_c of this voltage is

$$E_c = \frac{C_2}{C_2 + C_1} R_2 I_D \quad . \quad . \quad . \quad . \quad (14)$$

Taking the ratio of E_R (See Eq. 9) to E_c we have

$$\frac{E_R}{E_C} = \frac{Kx(C_2 + C_1)I_D}{C_1 C_2 R_1 R_2 I_D} = \frac{d_R}{d_C} \quad . \quad . \quad . \quad (15)$$

This equation may be written

$$x = \frac{C_1 C_2 R_1 R_2}{(C_1 + C_2)K} \quad \frac{d_R}{d_C} \quad . \quad . \quad . \quad (16)$$

Here again all the terms in the factor $\frac{C_1 C_2 R_1 R_2}{(C_1 + C_2)K}$ are constant except R_2 which de-

pends upon the setting of switch R_2. If the readings S_R of this switch be given the values of this factor instead of the values of R_2 then we shall have

$$x = S_R \frac{d_R}{d_c} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (17)$$

Now, as in the previous case, the readings of this switch will represent the deflections which x will have when $d_R = d_c$. The usual method of recording will again be to set switch S_R to the maximum deflection that one expects to record. Then by alternately throwing switch 3 to the calibrating and recording position, the transient may be observed in the oscillograph. The amplifier is adjusted until the transient shows a reasonable deflection. The setting of the armature in this case is preferably in the mid position. It is a simple matter to determine this setting. Headphones placed across the armature coil should record a minimum signal when the current in the primary circuit is rapidly altered. The primary circuit may be interrupted by means of a switch or by connecting in a buzzer or the 600 cycle current may be used. When the armature is adjusted approximately to the mid position, the equipment is ready for recording.

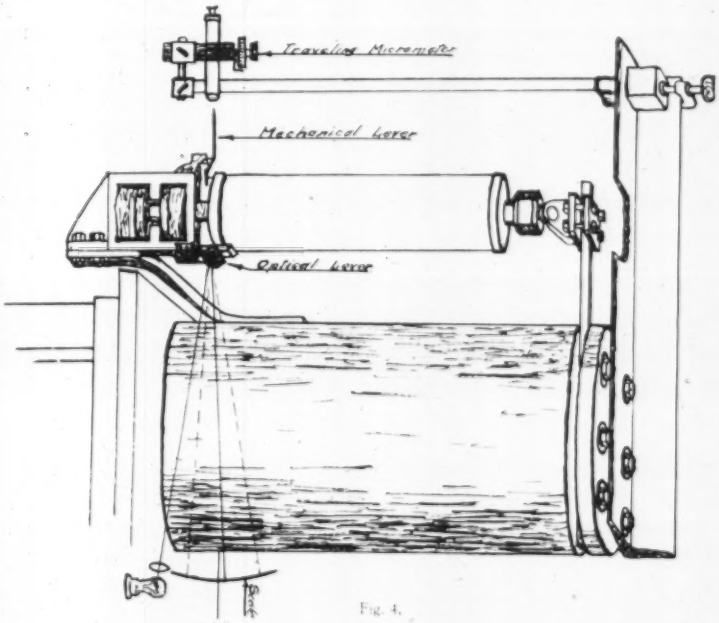


Fig. 4.

DETERMINATION OF THE CALIBRATION CONSTANT K OF THE RECORDER

In order to secure the calibration constant of the apparatus it was first necessary to calibrate an optical lever. This was done by means of a mechanical lever and a traveling microscope. (Fig. 4) A steady deflection of the armature of the stress recorder was amplified about 8 times by the mechanical lever. The motion of this lever was followed by the traveling microscope. The smallest division on the scale of the traveling microscope was 0.0005 cm. By reading the travel of the microscope one could determine the distance traveled by the armature. By recording at the same time the distance through which the spot of light from the optical lever traveled, it was possible to determine the amplification of the optical lever. This amplification was about 1000:1.

Now if one excites the field coils of the strain recorder, by means of alternating current and applies a steady deflection to the armature and if the oscillograph deflections resulting from the strain recorder are determined simultaneously with those from the optical lever and traveling microscope, one may then readily obtain the constant K of the recorder. In equation (12)

$$x = \frac{M\, d_R}{K d_c} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (12)$$

the value of the oscillograph deflection d_R and of the armature travel x will be known. To

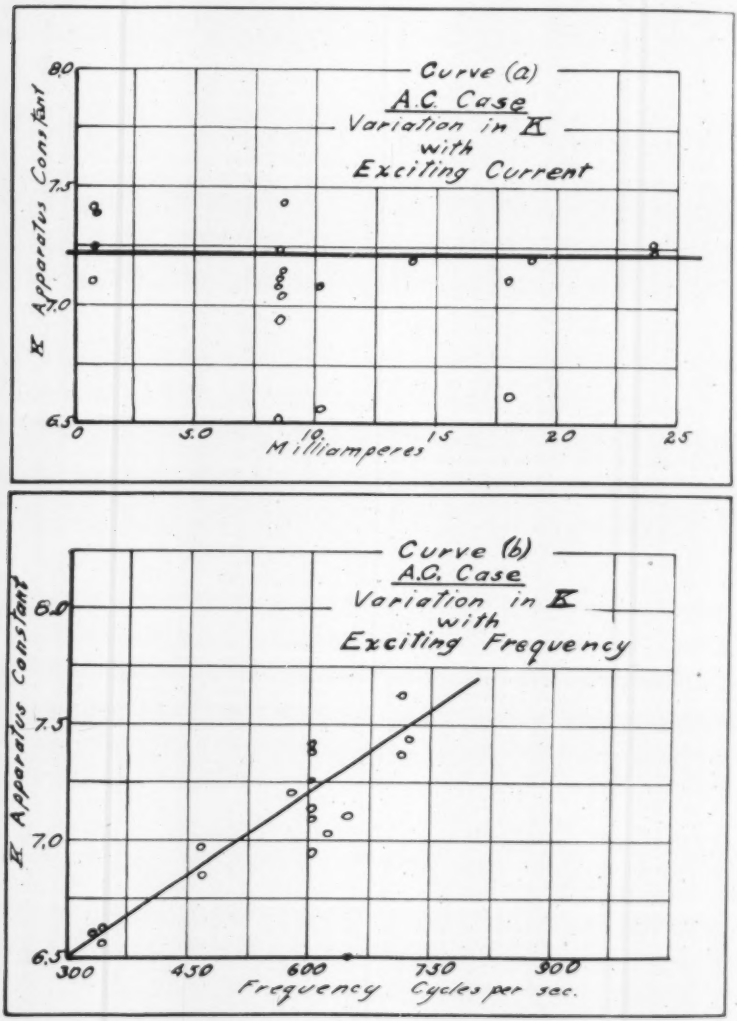
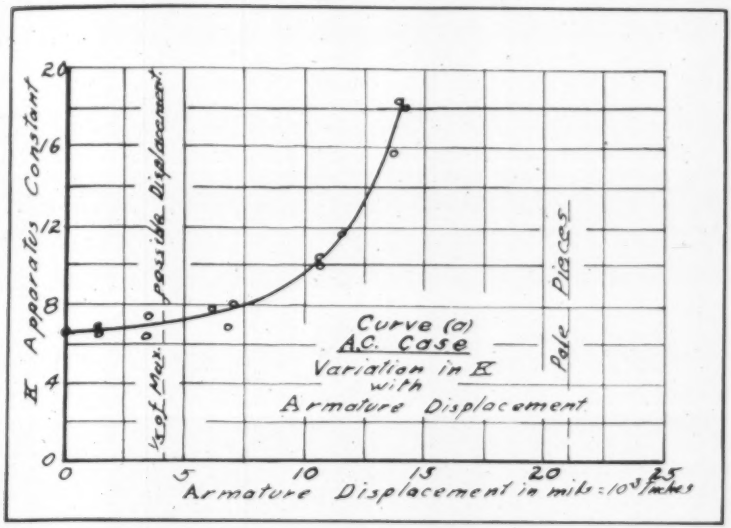


Fig. 5

obtain K it is only necessary to determine the values of dc and M when switch 2, Fig. 3 is in the calibration position.

This determination of K is under the assumption that the armature suffers a steady deflection. Now if under the influence of a vibratory or impact force the curve traced on the oscillograph by the optical lever is proportional to that traced by the recorder and if, using the same constant for the optical lever we obtain the same constant K for the recorder under these vibratory deflections we may then safely assume that both the constant of the recorder and that of the optical lever are correct not only for steady deflections of the armature but also for vibratory deflections.

It is still necessary to determine the constant of the apparatus for the case where the field coils are excited with direct current. Since the optical lever is known to record vibratory displacements accurately and since its constant has already been obtained, this determination is readily made. In equation (16)



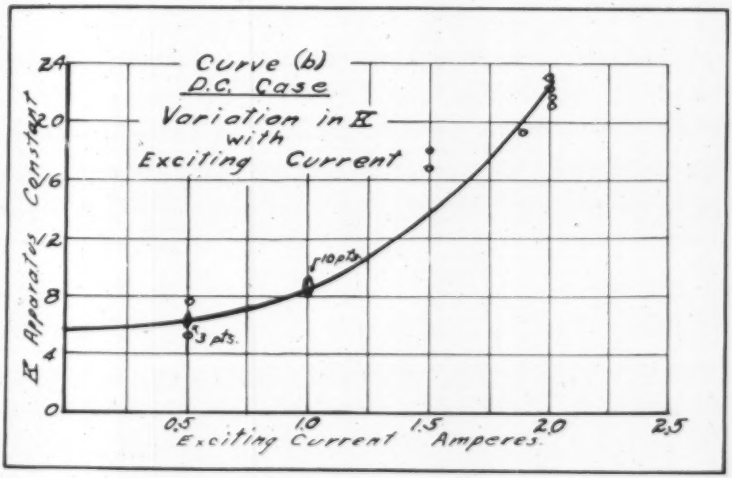


Fig. 6

$$x = \frac{C_1 C_2 R_1 R_2}{(C_1 + C_2)K} \frac{d_R}{d_C} \qquad (16)$$

the values of C_1 C_2 R_1 and R_2 may be readily measured. The other constants are determined in a manner similar to that outlined for the A. C. case except that x in this case must be obtained from the optical lever measurements. The value of K for the case of D. C. excitation is of course theoretically equal to that where A. C. excitation is used. In practice, however, the 2 values are not alike due to the widely different conditions under which the iron is used.

SUMMARY OF THE DATA

An average value of K obtained from 46 measurements using A. C. excitation is 6.77, with a probably error of 0.023. This represents a probable percentage error in this average value

of K of 0.34%. The probable error in any one of the readings composing this set of 40 is 0.16. This represents a probable percentage error in any one value of K of 2.3%. This error is of particular interest since it represents also the probable error in any one reading of armature displacement. Not all of this error may be assigned to the recorder. Part of it must be assigned to the errors in reading the traveling microscope or in readings of the optical lever. In view of this the probable error in the recorder alone for any one reading will hardly exceed 1.0%. This error occurs under normal operating conditions and with roughly 2 inch

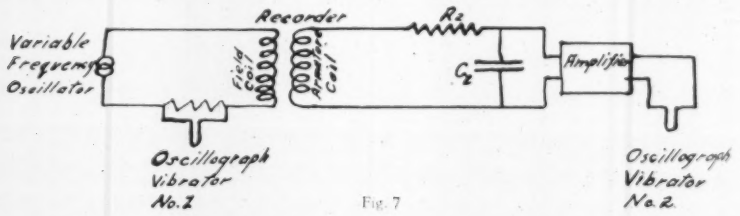


Fig. 7

deflections on the oscillograph screen. It will be of interest to determine over what range of values K may be assumed constant.

Curve (a) Fig. 5 shows that there is practically no change in K for variations in exciting current from 1 to 25 milliamperes. It will be noticed that the points are grouped about the value K = 7.2 instead of 6.77. This is the result of an incorrect reading of the setting of M.

Curve (b) Fig. 5 represents the variation in K for wide variations in the frequency of the exciting currents. A 1% change in frequency produces only .17 change in K. Since the frequency may readily be determined to within 1% or 2%, this variation in K is not considered serious.

Curve (a) Fig. 6 shows the variations in K as the armature deflection increases. The armature deflections were increased until the armature almost struck the pole pieces. It can be seen that for a displacement as great as $\frac{1}{5}$ the gap length there is no serious variation in K. In this particular apparatus $\frac{1}{5}$ the gap length represents about 0.004 inches. This represents the largest deflection that may be measured. The smallest deflection that will produce full scale deflection is about 50×10^{-6} inches. The faithfulness of reproduction has not been checked at this setting but there is no reason for supposing the record unfaithful.

A comparison of the values which K has when the armature vibrates rapidly, about 60 times a second, with the value it has when the armature suffers a steady deflection shows that this ratio is almost unity. An average of 14 determinations of this ratio is 1.01 +0.003 where 0.003 is the probable error.

We may turn our attention now to the case where D. C. excitation is used in the fields. Most of the difficulties in the apparatus were removed by a study of it with A. C. excitation. As a consequence only a small amount of data is available for the apparatus under D. C. excitation.

The following 4 readings of S_R, however, will indicate the accuracy with which this constant may be determined.

S_R, Switch R on Position 2.	% Error
1.216×10^3	1.94
1.254	1.13
1.226	1.13
1.262	1.78
Average 1.240×10^3	1.50

Curve b, Fig. 6, shows the variation in S_R with variation in D. C. excitation. The values given are not the values of S_R but are proportional to it. About 1 ampere is the normal operating current. At this value a 1% change in operating current will produce a 0.5% change in S_R. It is, therefore, necessary that this current be kept constant. In practice this current may be conveniently kept constant by employing as a source of excitation a storage battery which is kept charged.

To determine the variation in S_R as the armature is moved from its mid-position the armature was given a sustained mechanical vibration. The peak value of this displacement was about 1.75×10^{-3} inches at a frequency of 90 cycles per second. The resulting records from the optical lever and the recorder were then superimposed on the oscillograph screen, first adjusting their amplitudes to be equal. Keeping the 2 records superimposed, the armature was then given

a fixed displacement from the center. The first difference in the amplitude of the 2 records that could be detected occurred at a fixed displacement of 5.6×10^{-3} inches. At a fixed displacement of about 15×10^{-3} inches the discrepancy between the 2 records resulted in an 8% error. In view of the results with A. C. excitation this error is less than might be expected. However, saturation effects due to the relatively large D. C. exciting current will account for the smaller error.

The effect of a variation of mechanical frequency on the recorder constant was not determined by direct measurement of armature deflections, since this would have involved an unwarranted amount of time. Instead the circuit shown in Fig. 7 was used.

The oscillator was adjusted for some normal frequency. Oscillograph vibrators No. 1 and No. 2 were adjusted to have equal amplitudes and their records were superimposed. Now if the frequency were varied and the records remained superimposed, it meant that the response of the recorder and the integrating circuit, R_2 and C_2, and the amplifier were the same for this new frequency as for the other. This method did not take into account errors arising from strains set up in the recorder parts. By this method the 2 oscillographs records remained superimposed for a frequency range from 50 to 600 cycles. At 37 cycles the response had dropped to 0.975 of its correct value. At 900 cycles the response had dropped to 0.95 of its correct value.

INSTRUMENTS BOOK SHELF

The books reviewed in this section can be supplied by the Instruments Publishing Company.

Aeronautical Meteorology. *Willis Ray Gregg.* Ronald Press Co., New York, Revised, 1930. Cloth, 6x9, 440 pages. Price $4.50.

This volume, which contains numerous illustrations, is intended to supply a fundamental understanding of atmosphere and weather conditions for every-day use by the practical operator. Several sections by meteorological experts in their respective fields are contained in this revised edition, so that information concerning fog, ceiling and visibility, ice formation on aircraft, weather forecasts, instruments and methods of observation, airship meteorology, and the Weather Bureau airway service is right up to the minute. The essential facts about the upper air and their relation to the development and safety of aeronautics are written in a style to suit the practical operator.

Handbook of Chemical Microscopy, Vol. 2, Chemical Methods & Inorganic Qualitative Analysis. *E. M. Chamot & C. W. Mason.* Wiley & Sons, New York, 1931. Cloth, $6\frac{1}{4} \times 9\frac{1}{4}$ inches, 411 pages. Price $4.50.

Time is worth saving, in qualitative chemical analysis, as in other technical operation. Occasions arise from time to time in which an analysis is needed on material too scanty in amount for an analysis by ordinary methods. The skilled chemical microscopist can, for example, rub off from an alloy sample an almost weightless streak on a fragment of unglazed porcelain, dissolve that trace of alloy, place a tiny drop of the solution on a microscope slide, add a suitable reagent, and in a twinkling tell with certainty from the appearance under the microscope of the crystals formed whether a certain metal sought is present or not. The convenience of the microchemical method makes it of great value wherever qualitative analysis is required.

Professor Chamot is the greatest living authority in this field, and most Americans skilled in it have gotten their skill directly from his instruction, or from being taught by those whom he has instructed. The methods deserve even wider use and appreciation. Chamot's previous book helped toward this, and the present edition by himself and his disciple, Mason, will help still more. It contains some 160 photomicrographs of the crystals produced by the reactions used, just as one sees them under the microscope, together with details of the micro-manipulation and discussion of the reactions involved.

The authors point out the limitations of the methods and do not claim a bit more for them than is deserved. Interferences by other elements than the one sought are pointed out. In many cases, however, the reagent used is specific; when it produces a given sort of crystal, it shows that the one element sought is present. This is in great contrast to the complex separations so often necessary in the usual schemes of qualitative analysis, and is the reason for the vast time saving realized when the micromethod is applicable.

Many years of patient work were required to establish the conditions under which reliable specific tests are possible. The fruit of these many years of labor is given in this book.

It is unlikely that the average chemist could become a really skilled microanalyst by merely studying the book without some other instruction, but with a few weeks' training such as is given by Chamot and Mason in summer school, he could, with the help of this book, handle almost any microchemical problem. It would pay many a firm to give some one of their analysts such training. It is to be hoped that many other universities will follow the lead of Cornell, now that such a complete text book is available, and introduce a course in micro-analysis, so that a greater number of competent micro-analysts will be trained.

The reviewer took the course under "Chammy" 25 years ago, and still classes it as one of the most interesting and useful courses ever offered to the chemist. His own observations of the applications of microchemistry lead him to believe that every metallurgical laboratory should have at least one analyst skilled in micro methods. The methods, and this book describing them, are most highly to be recommended.—H. W. Gillett.

DIE BERECHNUNG DER NEIGUNGSWIEGEBALKEN MIT FESTEM GEGENGWICHT IM BESONDEREN BEI GLEICHMÄSSINGER SKALENEINTEILUNG. *Karl Diehl* Wilhelm Knapp, Verlagsbuchhanglung, Halle (Saale), 1930. Paper, 5½ x 8¼ inches, 61 pages. Price 3.6 RM.

An inclined beam scale employs a physical pendulum which, under the influence of the load to be weighed, is deflected from its original position. The angle of deflection is read on a scale and forms a measure for the weight to be determined. Such inclined beams can be supported on knives but this has definite disadvantages, especially a non-uniform scale. The rigid supports on knives are, therefore, replaced by supporting curves, and also the load is suspended on a band around a certain curve. The present book discusses these different conditions and determines the shapes of respective marginal curves which are best made so that they can be replaced, to a sufficient degree of accuracy, by arcs of a circle. The means of obtaining a uniform scale and the conditions for uniform sensitivity over the whole scale, as well as the accuracy, are fully discussed. The whole book is written in a clear way with simple mathematics.—Max Hartenheim.

TECHNISCHE WINKELMESSUNGEN. *Heft.* 18 der Werkstattbücher. G. Berndt. Verlag von Julius Springer, Berlin, Second Edition, 1930. Paper, 6¼ x 9 inches, 75 pages. Price 2 RM.

Next to measurements of length, the measurement of angles is one of the most important requirements in industry and technique as well as in the laboratory. The present little volume deals with all possible apparatus as well all possible methods to accomplish this task, and besides, in each case the obtainable accuracy is carefully studied. The exact calculation of errors, which generally requires more knowledge of mathematics than the ordinary shop man is supposed to possess, is given in smaller print so that it can be conveniently passed over in studying the book. First are treated units and standards, then rigid angles and methods of testing of 90° angles and angles of 180°. The trigonometrical and optical measurement of angles is discussed in the next chapters, including the parallelism of surfaces. The testing of curves, tapering of facts, is especially thoroughly discussed, as is also the chapter on goniometric measurements. A further chapter is devoted to the reflection-goniometers and levels (spirit and water) and the pendulum-inclinometer. A very interesting measurement, though infrequent in shop practice, is the examination of divisions and dividing machines. The last chapter gives practical instructions for the construction of angles of 90, 60, 45 degrees and any other kind, either by geometrical or goniometric means. The conciseness of the book is greatly assisted by numerous figures and illustrations. Although tolerances, standards, etc., have special reference to German conditions the book is of use to any one interested in the whole field of angle measurements.—Max Hartenheim.

FORSCHUNG UND TECHNIK. *In Auftrage der Allgemeinen Elektrizitatsgesellschraft herausgegeben von W. Peterson,* Verlag von Julius Springer, Berlin, 1930. Cloth, 8 x 11½ inches, 576 pages.

How closely bound up are science and the engineering industries, and to what extent this fact is being recognized by the latter, has lately been shown by the publications, regular as well as monographs, of institutes and industrial firms. One of the best examples is this voluminous book, Research and Technique, which leads us into the scientific workshop of one of the great European concerns and shows most impressively the wide range of work going on in their laboratories. Subjects as purely theoretical as the electron-rays, the dual nature now attributed to light, are treated, because they may lead to some commercial application. A fine example of this kind is the paper by Brüche, Slow Electron Rays and their Technical Application. The wide reach of this collection cannot better be demonstrated than by showing the usefulness for the electrical engineer of the contributions of Fleischmann, Frochlich, Stein and Uhlmann and other on machine design, layout of power stations, limits of power transmissions, lighting, protection operation of machine etc., by K. Schaeff on the graphical treatment of laws of steam in nozzles; on economy in steam-storage plants. In the field of physics the papers on electrons and refraction of electrons are highly interesting. The manufacture and use of instruments finds valuable material in Becker's deflection of bi-metallic strips of metal, Kalkner's and Goldstein's treatment of measuring methods for very high-voltage systems. The designer of steam turbines gains information on the mechanical strength of the nozzles, the cable manufacturer on the strength of his paper insulation in highest tension cables. This is only a short selection of the 40 articles in the 576 pages of the volume which will show sufficiently what sum of intelligence is daily working to provide our industries with exact foundations to build on but also to find new ways for further development in the program not only in the industries but for the betterment of the life of all humanity. Print and paper, arrangement of material and illustrations are of highest quality and add further credit to the products of the well known publishing house.—Max Hartenheim.

On April 1st the Pittsburgh Branch of the C. J. Tagliabue Manufacturing Company of Brooklyn, N. Y., moved into new and enlarged quarters at 1026 and 1027 Park Building. Increased space now makes possible the carrying of much larger stocks of all TAG indicating, recording and controlling instruments; and thereby facilities prompt deliveries. The management of this branch office and the solving of instrumentation problems in this territory continues in the experienced hands of E. D. Wacker, District Manager, and W. A. Stoeltzing.

On May 1st, the C. J. Tagliabue Manufacturing Company opened a branch sales office at 2832 E. Grand Blvd., Detroit, Michigan. Greatly increased business in this section has necessitated this change from a jobbing connection to a direct sales branch with ample stock of all the indicating, recording and controlling instruments. Convenient inspection and prompt deliveries will now be assured. N. Kerr, who has had many years' experience in solving temperature problems, has been placed in charge of this completely equipped TAG branch office.

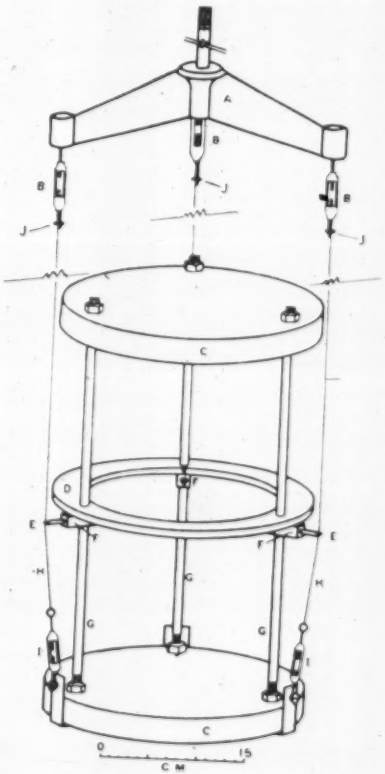
Note on Julius Suspensions[1]

M. J. Brevoort[2]

INTRODUCTION

RESEARCH work in the Bureau of Mines cryogenic laboratory requires the use of high sensitivity galvanometers of the d'Arsonval type in a building that is subject to unusually severe vibrations. A modified form of the galvanometer suspension described by Julius[3] has damped the vibrations so successfully that a short note concerning it is thought to be desirable.

The laboratory is on the site of the Amarillo helium plant near a building that houses gas engines of from 180 to 250 hp., driving compressors and electric generators. The distances from the galvanometers to the individual engines range from about 80 to 180 feet. The subsoil, consisting of black clay loam, transmits the impulses without much damping. The usual methods of protecting galvanometers from vibration were tried and proved fruitless. A Julius suspension purchased on the market was carefully installed in the hope that it would overcome the difficulty, but the conditions were too severe even for this elaborate arrangement. Several modifications of the original Julius suspension, which were then introduced, resulted in almost complete elimination of all vibrational effects.



These modifications were suggested by careful study of the original idea embraced in the Julius construction. They were designed to give further constraint to motion in any direction other than that parallel to a line from the point of support through the center of gravity of the suspension. This was accomplished by making the suspended frame more rigid and by improving the means of adjusting each of the supporting wires to the same degree, thereby transmitting any impulse symmetrically through the three wires. The result was a suspension that is more effective, particularly for severe vibration, than the form described by Julius; also, it is believed to have advantages in stability, simplicity, and ease of adjustment

1. Reprinted from U. S. Bureau of Mines Report of Investigations 3086.
2. Assistant physicist, cryogenic laboratory, U. S. Bureau of Mines, Amarillo, Tex.
3. W. H. Julius. Ueber eine Vorrichtung um Messinstrumente gegen die Erschütterungen des Bodens zu Schützen. Annalen Physikalische Chemie, Vol. 56, 1895, page 151-155.

over the few suspensions for this type of service that the author has found described in the literature.[4]

CONSTRUCTION OF SUSPENSION

The suspension used in the cryogenic laboratory (Fig. 1) consists of two cast-iron disks C, each weighing about 10 kilograms, suitably spaced to accommodate the height of the galvanometer and held in position by the three rods G. Locknuts on these rods placed on either side of the disks hold them in position. The ring D, made of boiler plate about one-quarter inch thick, adds to the rigidity of the rods G. The small turnbuckles I are fastened to the lower disk C, and to the upper end of these are attached the supporting piano wires H, approximately 0.7 millimeters in diameter. V-shaped knife edges E extend from the small adjustable blocks F on each of the rods G. The wires H make contact with E and are looped at their upper ends over the pegs J on the lower end of the upper turnbuckles B. In fastening the supporting wires to the upper turnbuckeles, care is taken to insure virtually one-point contacts with the pegs. The wires are wrapped around the lower stems of the turnbuckles to fasten them securely. The turnbuckles B are mounted rigidly to the tripod support A, which in turn is rigidly supported from the ceiling by a single central connection as shown.

ADJUSTMENT

After supporting the tripod in position, adjustment of the suspension is started by putting the three pegs J in a horizontal plane. The contacts E are then placed in a plane parallel to the lower disk C and passing through the point of suspension of the galvanometer. Next, the upper disk is so adjusted that the contacts E lie midway between the two disks and the upper disk is parallel to the lower one. It has been found that by using disks with large masses, the shifting of the center of gravity due to the addition of an ordinary galvanometer is inappreciable. Should the center of gravity of the suspension be changed materially, the contact points E would have to be moved accordingly. The ring D should be just above the contacts E and made rigid by set screws. The contact points E should be so adjusted that they are equidistant from the vertical central axis of the suspension and are at intervals of 120° corresponding to the tripod support. The wires H and the turnbuckles I are now used to bring the disks into horizontal places. Small wads of cotton[4] on adjustable rods externally supported make contact at E to provide an efficient damping arrangement.

The primary requisite for success is that great care be exercised to make the suspension symmetrical about its vertical axis, thereby putting equal tension in each of the three wires. The result is that the vibrations come down the wires in phase, causing only a negligible rising and lowering of the suspension. If symmetry is not attained, the vibrations come down the wires out of phase, causing wabbling of the entire suspension and excessive vibration of the galvanometer.

4. Frank A. Laws. Electrical Measurements. McGraw-Hill Book Co., New York, 1917, page 49.
A. L. Johnsrud. A Suspension for Supporting Delicate Instruments. Journal Optical Society of America, Vol. 10, 1925, pages 609-611.
Wilhelm Volkmann. Eine einfache schuetterfreie Aufhaengung. Physikalische Zeitschrift, Vol. 12, 1911, page 75.

The Bristol Company, Waterbury, Connecticut announce the removal of their Pittsburgh office May 1, 1931 to Koppers Building, 436 Seventh Avenue, Pittsburgh, Pa.

THE HANDBOOK OF INDUSTRIAL INSTRUMENTS

CHAPTER XIV

Timing and Scheduling Instruments

M. F. Béhar*

1. The Field of Time Instruments in Industry

(a) Duration

On the one hand, strictly to limit this chapter to "Time" would rob it of practical value to industrial engineers, who leave to observatories the *measurement* of time (i. e., time period) and who know full well that its *control* is only a philosophical dream. No user of this handbook wants this chapter to include a treatise on horology, and few industrial readers are interested in chronometry. The only time measurements we are interested in are measurements of the durations in which things occur—measurements of time intervals related to mechanical operations, to chemical processes, to work done by men or machines, to the efficiency of various types of equipment . . . to dollars and cents. And by the same token the only "time control" we care about or can do anything about in industry is the control of the performance *in* time of our equipment and of the workers on our payrolls—including ourselves. It isn't "time" that is money; it is what is being done during periods of time. This is the true import of the solemn old saying, and only a child or a savage would fail to grasp it.

On the other hand this chapter could take in all recording and registering instruments employing charts that travel or rotate "by the clock" (as distinguished from recorders having charts that move without respect to time: extensometers, engine indicators, etc.). Thus a recording thermometer is a time recorder, showing "when" the temperature was correct and "when" it was too high or too low. On this basis there would be little need of a special chapter—an index of the descriptions of recorders throughout this book would do just as well.

But the very importance of the time element in industrial work, and the realization that "time is money," have led to the design of numerous instruments related *primarily* to time. A stop watch—to take the simplest example—may be used equally well in connection with a drill press, lathe, boring mill, planer, shaper, milling machine, hobber, slotter, bulldozer, header, forging press, bending rolls, profiler, tapper, cold saw or crusher—to cite only metal-working machine-tool applications. That the simple pocket stop watch has evolved into various specialized industrial instruments is due to this importance and to this realization.

Considerations of *time-efficiency* naturally follows, and naturally bring up the subject of *speed*. Instruments for the measurement and control of speed have also evolved, but along different lines. Speed and acceleration instruments are therefore dealt with in a separate chapter—merely as a

*Engineering Editor

matter of convenience. (Note in this connection that even a *recording* speedometer belongs in the next chapter although it is doubly a time instrument.)

The scope of the present chapter thus begins to define itself: it takes in the industrial instruments designed primarily with regard to time intervals, periods or durations.

Within this province we must distinguish two considerations that have nothing to do with each other except that both view time as a processing or working condition. One was mentioned above: it is expressed in the adage that time is money; it may be called the economic consideration; it is justified by the necessity for financial return on investments in (a) plant and equipment that inevitably depreciate and (b) in rentals, taxes, interest, labor and other inevitably periodic items; it implies that the *shortest* duration is the optimum time period for doing anything. Carried to its logical extreme its aim is to reduce periods to moments; its ideal is the Instant. The other consideration is imposed on us by the nature of things, which forces us to recognize that entirely apart from the financial value of time, there is One Best Duration in the same sense that there is only one optimum temperature. Illustrations abound, and that of the proper duration for boiling eggs is obvious. In industry the best illustrations are furnished by chemical processes: No chemical process is instantaneous even if the reaction itself is instantaneous. Some processes are "slow" because the complete reactions—governed by natural laws—take place in definite periods. Other processes (most, in fact) exhibit *cumulative time effects* or gradual changes in the materials involved—the time-rate of the effect or change being governed by natural laws—and hence call for the exercise of scientific judgment. The optimum duration may then depend on specifications, as in steel treating; it may be governed by trade conventions, as in the drying of lumber and textile fibre products; it may be fixed by law, as in the preparation of near-beer; it may follow public taste, as in scores of cooking processes in the food industries; or it may simply depend on personal preference, as in boiling eggs. But in all such processes there is One Best time period—a definite duration which is *not* the shortest.

Often the two considerations are both involved. Thus the depth of case-hardening increases with time, but so does the cost of this treatment, and it would be ruinous to time the carburization of small parts of domestic appliances as one would that of airplane engine parts. A proper balance must be struck, and the "optimum" period then lies between the "shortest" and the "best" or "ideal."

(b) Sequences, Schedules, Cycles and Programs

So far we have only considered total duration. Another industrial aspect of time is often of importance, and has led to the development of special instruments. Every engineer knows that there are (1) single processes the total time of which is necessarily divided into periods, (2) operations or processes consisting of interdependent elements that require synchronization or coördination, and (3) combinations of such requirements—all the way up to the operation of an entire plant considered as a harmonious whole. Again each period in a multiple-period process, or each operation in a sequence of operations, may be related to the same "processing condition" (such as pressure) but in a degree differing from the others. Thus in a simple hydraulic press there are at least three periods: in the first, the pres-

sure is built up; in the second it is held, and in the third it is released. Similarly, a process involving heat is necessarily divided into a heating or "rising" period, a holding period and a cooling period — whether this fact is disregarded as in heating a rivet, where the length of holding matters little and the cooling period not at all; or whether it is seriously recognized, as in the processing of many rubber and plastic compound articles, where even the cooling period has to be judiciously timed.

There are also cases where the rate of change of a processing condition must not be left to itself. This brings up the most modern factor for which time instruments have been developed, namely, the shape of the "condition-time" curve in a given period ("condition" stands for temperature, pressure, humidity, current density, etc.). In the case of a 15-minute rising period, for instance, it may not be enough that the temperature should be, say, 70° F. at the start and 1570° F. at the end of the fifteenth minute: this merely defines two points on the curve and leads to the assumption that a straight-line increase of 100° per minute is desired, whereas a study of the process may have shown that an *f* curve would produce the best results at the least cost. Such processes call for automatic condition-time control instruments, together with recording instruments to report how closely the desired course is being followed. Such processes and requirements also call for processing equipment that lends itself to the application of modern automaticity. (Attention is invited to the little sermon at the start of Chapter VIII on Temperature Control.)

Apart from such natural stages or periods of a processing condition, there is often an urgent practical need for dividing a total duration into definite periods in order to obtain the best results at the least cost. The simplest example is that in which the interval is nil: if simultaneous operation of two valves, say, is desirable, it obviously is preferable to operate them automaticaliy by the same electrical, pneumatic or hydraulic impulse, instead of relying on manual operation. If a five-second interval is decided upon, it obviously is even more advisable to install an automatic timer. If a third valve (or the first) has to be operated at the end of a second definite period, then we begin to have a *cycle*, *schedule* or *program*. These three words are used indifferently by the instrument makers. They each refer, however, to an ordered sequence of events, and thus broaden the definition of the scope of this chapter.

Sometimes we want a gradual change instead of a sharp opening or closing of a circuit or valve. The mechanical solution, of course, is a *cam*. The result is also a sequence, but an infinite sequence of infinitesimal changes.

(c) True Elapsed Time.

Labor is the biggest cost item in the majority of industrial activities. Labor is generally bought in the form of time. It follows that every industrial establishment sells time. Therefore, entirely apart from special time-studies and motion-studies aiming at the determination of individual, group, machine and process efficiencies, it is of the utmost importance to be able to determine the true time cost of every item that is sold — whether the time is sold directly as a service job, or indirectly in the shape of a manufactured article.

The only way to determine the time cost of any item is to *measure* the time devoted on that item, segregating this time and deducting off time such as lunch periods. The accurate measurement of true elapsed time is seldom

a simple and easy matter even in the case of a one-employee establishment. And when the problem is complicated by diversity of jobs and multiplicity of departments and employees, a system for recording elapsed time becomes a necessity.

The less the system depends on the human element, the better it is. Hence the development of industrial instruments for this sole purpose. At this point we may insert portions of a discussion of this subject prepared by the Calculagraph Company:

From an experience of many years with factory managers, superintendents, cost accountants, and others, we know that in many industries where accurate time records are required, there is a lack of appreciation of the true value of elapsed time for labor cost and pay roll purposes, as compared with records of start and finish only.

If Jones, a workman, starts a job at 7:48 A. M., takes a half hour off for lunch and finishes the job at 3:22 P. M., it is necessary to determine the exact interval of productive time before the labor cost can be determined. This interval is an *Elapsed Time Record*. Some of the various ways in which elapsed time records are obtained in manufacturing and printing plants, repair shops, etc., are the following:

The workers write on their cards the time taken, or "Elapsed Time."

The workers write the time-of-day starting and finishing each task on a time ticket so that they or a clerk may subtract the one from the other and write down the "Elapsed Time."

The workers report to a clerk who writes down the starting and finishing times and subtracts and writes the "Elapsed Time."

A clerk goes to the workers, writes down the starting and finishing, subtracts and writes the "Elapsed Time."

A time stamp or time-of-day recorder is used to print the start and finish of each job and a clerk subtracts one from the other and writes down the "Elapsed Time,"

A Calculagraph is used to print the starting time, the finishing time, and the Elapsed Time. It does all the work—not merely part of it.

The faulty element in most unsatisfactory systems of determining labor costs is that they depend too much upon human effort. Systems which permit a workman to make his own distribution of time for each job are scarcely more objectionable than those wherein a cost clerk figures elapsed time from records showing only the starting and the finishing time.

Go to any establishment where the first-mentioned system is in operation. Observe the workman "fixing up" his time card at the close of the day . . . Much guessing and some dead reckoning finally establish the fact that the total time for the four jobs was two hours less than his entire working time for the day, and as the whistle has just blown, he adds thirty minutes impartially to each job and turns in the card, secure in the belief that it will "balance" and that the "boss can't kick". . . Systems which permit a workman to make his own distribution of time are infinitely worse than no system at all, because the records produced can never be correct, or even approximately so, and also because it wastes the time of high-priced employees.

Scarcely less objectionable is the practice of detailing special clerks or timekeepers to ask mechanics the number of hours and minutes spent on each job. Experience teaches that the average clerk does not accurately record elapsed time by means of a pencil and clock dial. The time of commencing, as shown by the dial, may be read wrong, or having read it aright he may record it wrong. Either or both of these errors may occur again in recording the finishing time. And a most prolific source of error is in subtracting the commencing time from the finishing time.

As to plain time stamps (states the Calculagraph Company) such machines are relics of the days before the calculating machine of the present time was invented. You would not think of using a number printing machine for work demanding an adding machine—then why use a time-of-day printing machine where an elapsed time recorder is needed?

2. Classification

The usual division into indicating, recording and controlling may be adopted. The meanings differ somewhat from those understood in dealing with other instruments. Thus a time *indicator*, outside of the industrial field, is simply a timepiece indicating the time-of-day; whereas an industrial time indicator shows the elapsed time and is really a registering instrument

A time *recorder* does not record the mere passage of time but it usually records the performance of the machine or processing equipment to which it is applied. And, finally, a time *controller* is a mechanism that does not in the least influence the flow of Time (but rather obeys it, for it is driven by a clock) and which actuates valves, switches, levers, etc., according to a schedule.

(a) Indicators

Time indicators or non-controlling timers may be classified along various lines. One division is according to whether the reading increases or decreases, i. e., whether zero on the dial indicates the start or the end of the period. Along a different line they may be divided into three types: (1) Those that are independent and therefore must be manually started, stopped and set to zero. The stop-watch and the photographic timer are examples. (2) Those that are started without manual assistance, being connected to a machine or apparatus, but requiring manual zero setting. (3) Same, but the pointer is automatically brought back to zero (or to zero elapsed time) when the timer is restarted. Another classification is by clockwork: (1) Spring and (2) electric. Another possible classification is into signalling and non-signalling models. Most industrial non-controlling timers actuate visible or audible signals at the end of the period for which they are set, and the boundary between them and the controlling timers is vague and shadowy.

Descriptions of some industrial time indicators are given in Section 3.

(b) Recorders

All time recorders are autographic, but not all industrial instruments with clock-driven charts are time recorders. There is no definite dividing line, and it is frequently impossible to tell by examining an instrument whether it should be called a time recorder or some other kind of recorder. The author has asked manufacturers to lay down a definition but not one manufacturer has committed himself. This very uncertainty suggests a definition guaranteed to please everybody: An industrial time recorder is a recorder, the charts (or other forms of records) of which are examined and employed *primarily for industrial time-study purposes*. The reasons for including "or other forms of records" in our definition is that some types of autographic time recorders (of which the familiar time stamp is an example) do not produce charts. These devices are not usually though of as industrial instruments at all, being considered "office appliances" or "business machines," but some models are designed for industrial operations and processes and deserve to be included.

As with recording thermometers, gages, electrical meters, etc., we may divide time recorders into (1) round-chart types and (2) strip-chart types, adding also (3) no-chart types. In connection with charts it is worth mentioning that many models of time recorders are small; their charts are small; the round charts are called "discs" and the strip charts are called "tapes."

An important classification of all chart-writing time recorders has to do with the two distinct kinds of records that the instruments are or are not capable of producing: One kind of record is the "on or off" record, of which the typical application is running and idle time, and which does not require a graduated scale on the chart in addition to the time scale. This kind of a record shows, for instance, the total number of "runs" or "heats" in a workday, the duration of each, the intervening idle periods, etc. The other kind

of record is the "measuring" record, which calls for a scaled chart, as in a recording pyrometer or any industrial measuring-recording instrument other than a time recorder. The author's original intention was to exclude all such instruments from this chapter. In other words, a time recorder was to be defined as one which did not or could not measure a variable magnitude. Theoretically, the idea was sound; and it would moreover have simplified the treatment of the subject; but in the actual designing, making listing, selling and utilizing of time recorders (especially of some elaborate models) this restriction is not always observed.

Another classification of recorders is into single-record and multiple-record types. An attractive feature about time recorders of the chart type is that the number of recording pens is limited only by the size and design of the instrument case. Foxboro, for instance, catalogs a 12-pen round-chart recorder in the 12-inch size and Bristol a 20-pen strip-chart recorder with a scale 5¼ inches wide which can be arranged to travel at speeds of one, three and six inches per hour. There are also multiple switching possibilities as with temperature recorders (for which see Chapter VII) whereby a number of pieces of equipment may be successively connected to the recorder, either manually or automatically. Then, too, there are combination instruments which record on one chart several time records pertaining to one piece of equipment. As a rule these combination instruments furnish only one strictly time record, the others being speed, temperature or other "measuring" records.

Time recorders are usually continuous-running, so that their charts are divided into weeks, days, hours or minutes, *i.e.*, into intervals of astronomical time. Special instruments are started simultaneously with the equipment to which they are connected, and their charts, while divided into usual time units, are not positioned with regard to time-of-day. Chronographs and oscillographs are examples of such special instruments. Regular instruments, too, can be used in this way, by simply disregarding time-of-day and positioning the chart at "12" or zero when a process is begun. Another division is into instruments requiring driving connections and those, such as vibration recorders, that need only be installed on the machine or vehicle. The division into spring and electric clocks also suggests itself. Several makes of industrial time recorders can be had with either type of drive.

Descriptions of some industrial time recorders are given in Section 4.

(c) Controllers

Such is the variety of time, program, cycle or schedule controllers that a good many classifications are possible. Many technical classifications, however, would only interest instrument-makers, and need not be emphasized. As with regulators for pressure, temperature and other conditions, there are on the market both *recording* and *non-recording* models of time controllers. Similarly, there are *signalling* as well as *non-signalling* time controllers. Some instruments embody *spring* clocks, others *electric* clocks. Even among single-purpose time switches we may distinguish several models, including those that are required to close one circuit at the instant that they open another—which brings up the difference between one-way and two-way contacts. Contacts in turn make us think of relays: it hardly seems necessary to classify controllers by *classes of relays* (not only electrical but pneumatic, etc.) or by the numerous types of electrical *relay circuits*.

The *current capacity* of different models, from that of a waffle-iron timer to that of a blast-furnace sequence controller, obviously varies a lot. The availability of models with or without *gear changes*, or with or without *speed adjustments*, does not surprise the reader and need not constitute a basis of classification. Another division could be into time controllers that start manually and those that start automatically. Again, these latter might be divided into those that start at the beginning of the process or cycle, and those that "wait" until some condition has been reached, when they then automatically start the desired sequence of operations. These may be called "interlocking." Among the self-starters we might also distinguish between those that stop at the end of their action and those that *repeat*.

One important distinction that has to be set down here, however, is that between "*shut-off*" action and "*gradual*" action. Any time-switch illustrates the first type of controller; the characteristic feature of the second is that instead of opening or closing a circuit or a valve, it *gradually* increases or decreases some controlled condition.

As will be seen in Section 8, there are elaborate controllers each of which combines several control units of different types and different modes of action into one coördinating instrument.

For the sake of convenience, the single-control models of time switches, etc., are first described, in Section 5. Section 6 deals with the development of "on and off" timing instruments into *sequencing* controllers. Section 7 takes up the principle of the *variable-condition* or "cam" control for effecting *gradual* changes. Finally we come to the combination instruments in Section 8. This progressive arrangement is fairly representative of the historical development of time controllers—a development that is still going on.

STRATEGY IN HANDLING PEOPLE. *Ewing T. Webb and John J. B. Morgan.* Boulton, Pierce & Co., Chicago, 1931. Cloth 6 x 9 inches, 260 pages. Price $3.00.

God damn you! In italics twice that size, these once unprintable words appear on the last page but one of this extraordinary book, and are ascribed to Charles Dawes, as the climax of a war episode related by the authors to illustrate the last of the useful rules which they lay down in their last chapter: *Also make it a point not to indulge in outbursts of temper, except for a specific purpose when you feel sure that this is the best way to handle a situation.*

In every chapter the stories or "cases" come first, the precepts generally at the end, in italics. The first in the first chapter declares: *One and all, great leaders are far more careful than most men in dealing with people. They take many precautions which lesser men neglect. They know that only through other people is it possible to succeed.* This idea runs throughout the work.

The readers of INSTRUMENTS strive to attain definite objectives by means of the optimum methods and mechanisms. What can be more natural than that in considering the problem of handling people, they should seek for the optimum available "instrument" for the purpose? While this work is not a magical instrument which will enable a young engineer or laboratory technician to outstrip his colleagues in a fortnight and become a high executive in a year yet we dare assert that any purchaser of this unprecedented "instrument" who does not profit from it, who does not learn to know himself and correct some of his tactless traits, who does not gain much greater confidence as a man amongst men, who does not feel a closer kinship with the Fords and Morrows and Swopes and Atterburys of this man's world, will have only himself to blame. For this volume does contain not only outstanding examples of successful handling of people, but also practical lessons as to how and when to employ each particular method. Therein lies its superiority over previous guides to conduct. In its matter (apart from trick chapter heads, etc.) the book is startlingly, nakedly, anatomically veracious. Never excusing, never condoning in relating hundreds of anecdotes that include "putting over deals," it is free from the hypocritical cant of outworn philosophies. It is probably the first compilation of precepts that is not built around the idea of bringing nearer the Kingdom of God; the first that does not preach humility, turning the other cheek, heaping coals of fire, virtue as its own reward, and other such roads to Salvation. Some may deplore and view-with-alarm the appearance of such a book, but none can help admiring the audacity of the authors (and publishers).—M. F. Béhar.

The American Applicance Co., 1214 Harney Street, Omaha, Neb., and the Ludwig-Austen Co., 625A West Second Street, Oklahoma City, Okla., have been appointed district sales representatives of Jas. P. Marsh & Company, Chicago, in their respective territories.

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You have been writing useful articles, and we have felt that they have been well done . . . This is good work and we would like to help. *S. C. Horn, Wilson-Maeulen Co., Inc.*

Your Handbook should be a "Bible" for instrument men. It will supply a long felt need and, believe me, I mean this when I say "long felt." *H. W. Stoetzel, Republic Flow Meters Co.*

We have been reading with interest the different chapters of the handbook written by you. *H. R. Bowers, Meriam Co.*

We think that the work . . . is par excellence . . . will help those people who have already started to become instrument-conscious to be really intelligent on the subject so that they can handle equipment with the greatest efficiency. *C. E. Sullivan, Foxboro Co.*

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The most comprehensive of any treatment I have seen. *Jonathan Sharp, Brown Instr. Co.*

I have been following with considerable interest what you have published in *Instruments*. It has been excellently handled. *R. L. Goetzenberger, Minneapolis-Honeywell.*

List of Chapters

1. Industrial Instruments—general. 2. Measurement of Temperature, Industrial Conditions, Classifications, High-temperature applications, etc. 3. Indicating Thermometers. 4. Thermoelectric Pyrometers. 5. Radiation Pyrometers. 6. Optical Pyrometers. Pyrometric Cones, etc. 7. Thermometric and Pyrometric Recorders. 8. Automatic Temperature Control. 9. Humidity—General Discussion; Measuring Instruments, Controlling Instruments; Air Conditioning Systems. Appendix—Useful Tables and Charts.

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NEW INSTRUMENTS

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New Snap Case-front Industrial Thermometer

(C. J. Tagliabue Mfg. Co.)

THE glass fronts on industrial thermometers will get dirty and under certain conditions "fog" up. The new snap case-front has been designed to make cleaning easy and at the same time, to make breakage of the easily removable glass front almost impossible. A tongue at the top of the case fits snugly in a groove in the front so that in either opening or closing the front it cannot slip and fall. It takes little effort to remove, clean and replace the new front which, when in position on the instrument, is herd firmly closed by the snap device illustrated in Fig. 1.

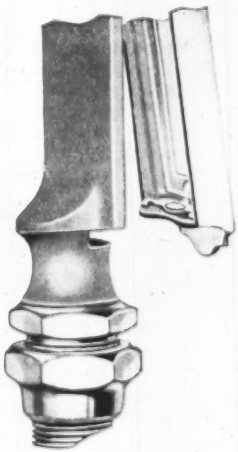


Fig. 1

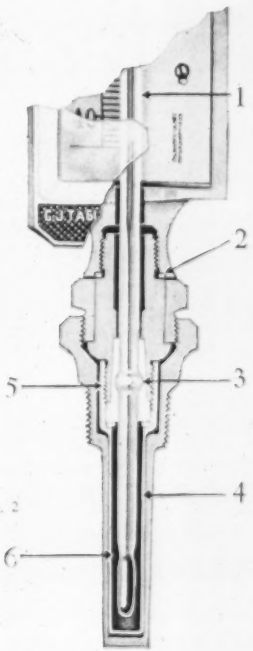


Fig. 2

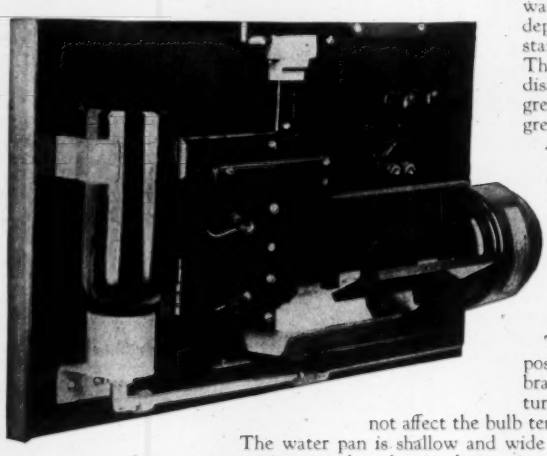
Other constructional features of this new industrial thermometer are clearly shown by Fig. 2: 1. TAG-Hespe glass easy to read; 2. Connecting piece, locked to case by a specially designed split spring washer; 3. Asbestos packing, uniformly compressed around enlargement on glass stem prevents movement of the tube with reference to scale; 4. The Monel bulb chamber is thin enough to allow quick conductivity, yet rugged and non-corrosive . . . cannot amalgamate with the mercury filling; 5. Left handed thread on bulb chamber prevents loosening if case is turned in removing thermometer from socket. 6. Mercury filling in bulb chamber completely surrounding bulb of thermometer insures transmission of heat with split-second rapidity.

New Wet and Dry Bulb Thermometer Fixture

(*Bristol Company*)

A NEW Wet and Dry-Bulb Thermometer Fixture has been placed on the market by The Bristol Company. There are several features in this new fixture eliminating, to a large degree, the errors common in such devices.

In the past it has been the practice to enclose the wet bulb with a metal cover and circulate air over the bulb by means of a fan and motor. With this equipment, the wet bulb depression was usually less than the depression as obtained with a standard sling psychrometer. The results were usually disappointing; that is, the greater the depression the greater the error.



A non-metallic cover has been used on the new fixture, arranged to have around the bulb a large amount of space for the circulation of air. This non-metallic cover eliminates almost entirely the error caused by room temperature radiation.

The bulbs are held in position by non-metallic brackets so that the temperature of these brackets does not affect the bulb temperatures.

The water pan is shallow and wide so that a large surface of water is exposed to the circulating air. This causes the water to evaporate from its surface and thus cooling it to a temperature near the wet bulb temperature. In this way water of the proper temperature is supplied to the bulb.

No soft soldered joints are supplied in the water system so that water corrosive to solder can be used.

Results from this wet and dry bulb fixture are very close to the standard sling psychrometer.

New Power Type Pressure Device

(*Bailey Meter Company*)

THIS device is in effect a dead weight gage tester combined with a hydraulic torque amplifier and a Sel-syn motor system of long distance transmission.

The power type pressure device, a sectional view of which is shown in Fig. 1, is located near the pressure to be indicated or recorded. This pressure is applied by means of the pressure connection at the bottom of the device to a small pressure piston which supports a pilot valve and a cup containing mercury. This portion of the pressure device which is continuously rotated to eliminate static friction is equivalent to a dead weight pressure gage tester, as the applied pressure is counterbalanced by the weight of the rotating parts and mercury plus reaction of the displacer in the mercury. A small motor which rotates the pressure piston pilot valve and mercury cup is also used to drive a small oil pump which provides the oil pressure required for operation of the power piston, displacer and Sel-syn motor.

When the applied pressure increases or decreases, the pressure piston rises or falls proportionately, and in so doing permits oil under pressure to pass through the pilot valve to the upper or lower side of the power piston. If the pressure is increasing the pressure piston, pilot valve and mercury cup move upward, thereby throwing the pilot valve out of its neutral position and applying oil pressure to the upper side of the power piston. This causes

the power piston to move downward, forcing the displacer deeper into the mercury. The reaction of the buoyant force of the mercury against the displacer will cause the mercury cup and pilot valve to be forced downward against the increased pressure under the pressure piston. This downward movement of the mercury cup, pilot valve and pressure piston returns the pilot valve to its neutral position and closes off the oil supply to the power piston. Consequently, for each pressure applied to the small rotating pressure piston, a definite position of the power piston and displacer is obtained. By driving a Selsyn motor from the rack on the power piston rod, the position of the Selsyn is an accurate indication of the applied pressure. Since the receiving Selsyn indicators and recorders assume the same position as the transmitting Selsyn, it is possible to secure accurate remote indications or records of the desired pressure.

By varying the diameter of the pressure piston, the size of the mercury cup and the size of the displacer, it is not only possible to furnish this power pressure unit for practically any maximum pressure but also for a very large suppression. The indicator shown in Fig. 2 permits of a total pressure range of only 30 lb. for an average operating pressure of 400 lb.

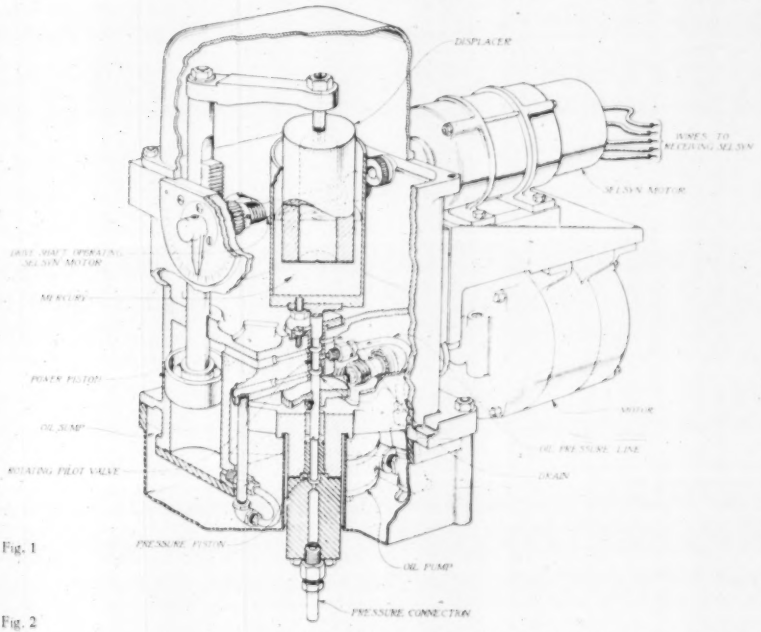
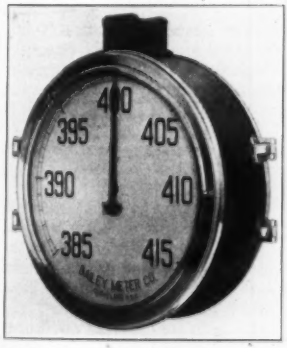


Fig. 1

Fig. 2



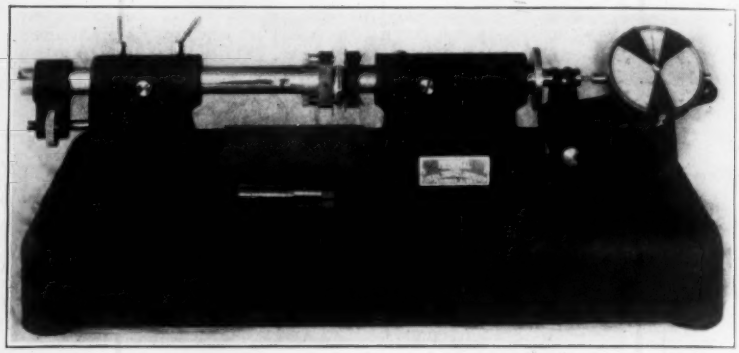
Since this type of indicator is 42" in diameter, each division which represents a pound covers considerable space on the indicating scale. Indicators of this type make ideal master pressure indicators for central station use. The possiblity of connecting as many as 12 or more indicators or recorders in the same master pressure circuit, makes this device a desirable means for indicating and recording master steam pressure. The Sel yn motor system of transmission, which is employed by this device, permits of the installation of master pressure indicators or recorders in the control room on the switch board without fear of leaks from pressure lines as has been the case heretofore.

If desired, the mercury cup can be designed so that the maximum pressure can be varied within limits by the addition or removal of weights. In this case, the compression is changed but the magnified pressure range remains the same.

Thread Checking Gage

(*Federal Products Corporation*)

THIS gage is designed for checking of taps, screws, thread gages and other miscellaneous products having threads to check. The dial indicator, which is graduated in 0.0001", is 3⅝" in diameter and the dial is calibrated 0-5-0 and equipped with a tolerance shutter which makes it extremely easy for operators to take readings in 0.0001" or considerably closer, as desired.



The gage uses the 3 wire method of measuring, the individual wire is floating and the two wires are semi-floating and can be instantly changed to allow for different sizes.

The gage has an adjustable spring pressure against the part to be gaged from ½ to 6 lb., and the work can be checked vertically or horizontally as desired. It will be noted that the tail stock has a vernier adjustment.

The gage is also made so that it can be operated either by hand or foot by the small lever shown at the right hand side of the illustration.

The overall hang of the gage is 24" and the approximate weight is 200 lb.

The Howe Weightograph

(*Howe Scale Company*)

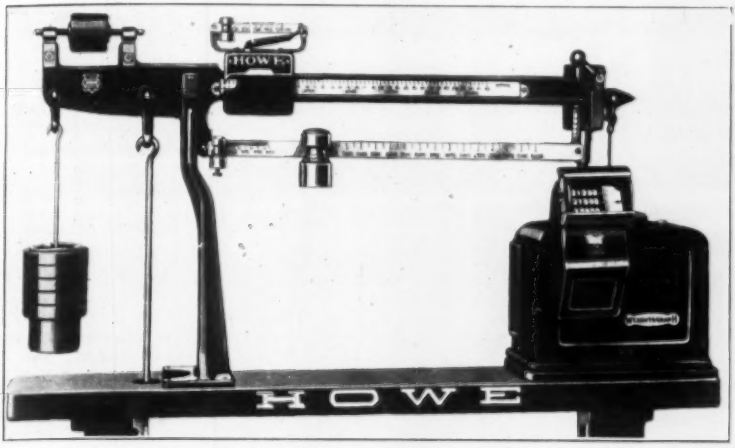
CONDITIONS today teach us that savings are as important as earnings in producing a profit. This situation has caused particular attention to be directed to the Howe Weightograph because its remarkable savings in time, labor or money can be effected without discarding present investment in scale equipment.

The Howe Weightograph is attachable to any built-in type of beam scale from 1000 lbs. upward. Dial scales are also convertible to Weightograph operation by merely removing the dial head; the remainder of scale being retained. The Weightograph is the only automatic weighing instrument that permits present scale equipment to be continued and to enjoy the benefits embodied in the Weightograph, says its manufacturer, The Howe Scale Company of Rutland, Vermont.

When attached to a beam scale (which of course has previously been operated manually by manipulation of the beam poises) the Weightograph provides automatic operation, thus eliminating the uncertainty and variableness of the human element.

It is not to be misunderstood by this that the Weightograph by its installation upon old scales, make new ones out of old. The Weightograph indicates exact performance of scale; no more, no less. It is this exact indication which is claimed as an exclusive advantage of the Weightograph: its accuracy reveals what the scale conceals. By that is meant that beam operation or pointer operation inhibit accurate indication—they are not absolute nor close enough to the absolute in their operation, to do what is claimed for the Weightograph.

Because intricate mechanisms are done away with; and there is no complicated machinery as racks and pinions, gears, friction, discs, compensating cams, weighing springs, and other



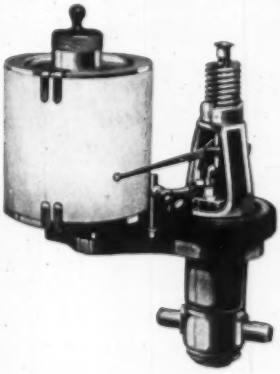
what not, it is said that the Weightograph achieves its superiority by its simplicity. There is only one moving element in the entire instrument — which on the face of it reduces complications to the irreducible minimum.

The principle involved is one regularly observed every time one goes to the moving pictures. Much the same, the Weightograph magnifies the movement of the weightbeam by means of a Precision Chart or negative. Thus the Weightograph employs optical magnification instead of the mechanical multiplication utilized by the other forms of automatic indicating scales. There is no friction, no wear and tear, and no error in magnifying and projecting a ray of light.

Indicator With Free-Rotating Drum for Taking Time Diagrams

(Lehmann & Michels)

IN addition to the usual diagrams taken with the piston path as abscissa, diagrams based on time also are of interest, particularly if the end of the stroke is of importance. In the former diagram, over the path of the piston, this is only represented in a greatly shortened scale. For instance, the beginning of combustion at the end of the compression period, the height of compression, too early or too late ignition of internal combustion engines, can be clearly recognized only from the time diagram. Very often, therefore, "diagrams drawn by hand" are taken which naturally have the disadvantage of a very non-uniform paper-speed and lead to erroneous conclusions.

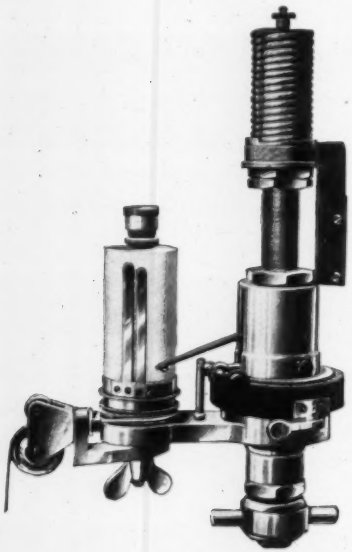


In very extended experiments, indicators with clockwork are used on which a long paper strip is turned by a clock with variable speed. For tests of shorter duration a very convenient and simple auxiliary device has been developed. In a second hole the drum holder carries a drum of great mass and inertia running in ball bearings which is set in motion by hand and rotates with constant speed due to its great inertia during the taking of the diagram. A sheet of paper is fastened around the drum and the speed of the latter selected so that either one or more cycles or a fraction of a cycle, f. i. an ignition or flushing is recorded. This method has proven to be extremely simple and practical so that it is applied to great advantage on reciprocating engines on the test-block. The size of the indicator used depends on the number of revolutions.

Indicator With Initial-Tension

(Lehmann & Michels)

THE absolutely reliable testing of compressors—volumetric efficiency, actual power consumption, mechanical efficiency, etc.—requires very special indicators. It is particularly difficult to indicate the high pressure stages on account of the high temperatures and the necessarily small dead spaces. Besides, the diagram of the high-pressure stage is very small when using normal indicators and therefore very inaccurate for the planimetering of higher pressures since the greater part of the recording length—up to the section pressure of this stage—remains unutilized.



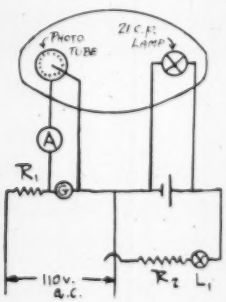
This disadvantage is eliminated in the initial-tension accessory by which the indicator spring is given an initial-tension of approximately the magnitude of the suction pressure. Only those piston pressures exceeding the initial-tension of the spring move the recording pen so that the full height of the card can be utilized for the compression stage. The initial-tension of the spring can be read on a scale. With the same method, the high-pressure cylinders of high-pressure steam-engines can also be indicated.

This approved additional arrangement can be supplied with any normal Lehmann-indicator of any size suitable for indicating steam-engines, internal combustion engines, etc. The selection of the size is made according to the number of revolutions, together with the pressures of the compressor stages. For especially high temperatures the indicating cylinder can be surrounded by a cooling mantle to avoid excessive heating of the indicator.

Constancy Test for Photo Tubes

*C. C. Hein, Jr.**

OF prime importance in problems involving light sensitive devices is the reliability of the unit which interprets the light signal in terms of electrical energy. A reliability test demands that all variables such as photo tube voltage and light source current be maintained



*Research Laboratories, Westinghouse Electric & Manufacturing Company.

constant. In order to remove these variable factors the accompanying circuit was employed.

The light source is a standard 21 c.p. auto lamp and is supplied from the 110 v.d.c. lines through an iron wire ballast lamp L, having a characteristic which permits a constant current to be maintained although the line voltage may vary considerably. The voltage drop across R_2 reduces the line voltage to the desired operating voltage of the lamp. The lead storage battery B, charged at a rate slightly less than that drawn by L_2 further tends to hold constant the current in the light source. With these precautions the light source was made very steady and could be relied upon remaining constant over extended periods of time.

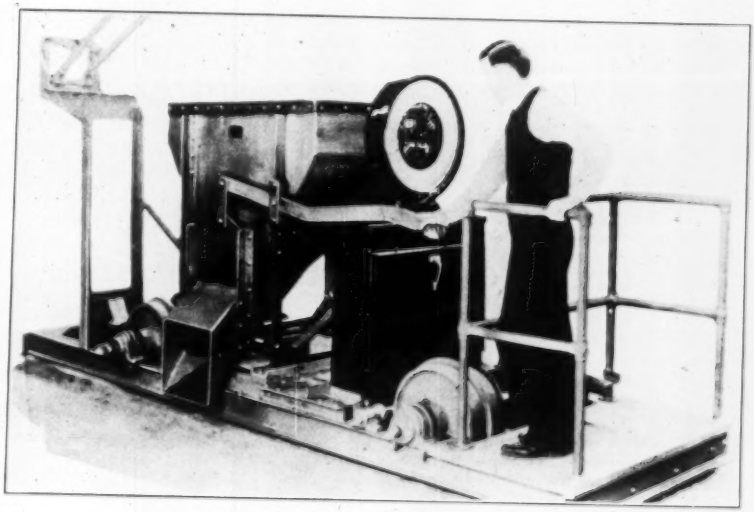
The constant potential for the photo tube was obtained by means of a gas discharge tube of the UX-874 type the voltage drop across which remains constant although considerable line fluctuations is experienced. R_1 drops the line voltage to the desired operating point for the photo tube voltage. The photo tube current is recorded without amplification on a recording meter using smoked charts. A continuous operating record for a twenty-four hour period is obtained.

The photo tubes tested had cylindrical cathodes and were capable of receiving illumination from all sides. In order to fulfill more nearly the requirements of operating conditions, the test was conducted in a highly polished cylinder for uniformly illuminating the tube.

Motor Driven Weight Car

AN electrical motor driven weight car for collecting glass batch has just been developed by the Stephens-Adamson Manufacturing Company and the Toledo Scale Company.

The car is built to carry removable hoppers which are interchangeable and eliminate the necessity of using the same hopper for different materials. They are of 2,800 pounds capacity. Each hopper has rounded corners to facilitate clean discharge and is equipped with a discharge



gate and chute. The car is fitted with a 6,000-pound capacity Toledo Dial Scale which registers up to 3,000 pounds in three pound graduations. The car is propelled in either direction, at the rate of 160 feet per minute, by a 7½ horse-power motor. It is mounted on underslung housings designed for industrial car service.

In operation the car moves through the mixing tunnel under the storage bins. Material is discharged from the storage bin into the scale hopper, which is mounted on the scale platform. Next it is discharged through the chute on the scale hopper into the furnaces.

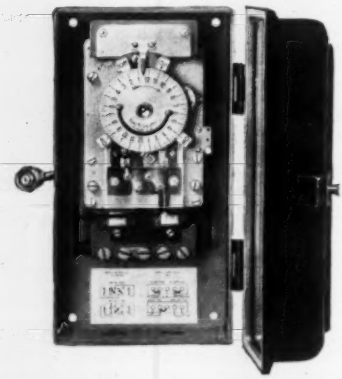
The operator can stand on the platform and conveniently read the weight indicator and move the operating lever at the same time.

Sauter Electric Time Switch

(R. W. Cramer & Co., Inc.)

THIS electric time switch can be used for all timed controls necessary for automatic operation, of coolers for drinking fountains, ventilators, heaters or melting pots.

The clock in this switch is designed specifically for time switch operations. Substantial oversized precision cut gears and hardened alloy steel pinions are used. This insures minimum wear from the intermittent duty the clock performs at switching time. The clock spring, which is automatically wound once a day, has a reserve power of three to four days. An ingenious clutch device prevents the overwinding of the clock spring. The 7-jewel escapement has an Invar balance wheel and Breguet hairspring. The entire escapement is easily interchangeable as a unit.



A small induction motor is used and comprises a complex unit with its reduction gears. The field can be connected in parallel or in series by means of jumpers for operation on 100-120 or 200-240 volt a.c. circuits. The motor consumes about 6 watts. An important feature of this system is that the motor is on the line only twenty-five seconds every twenty-four hours to fully wind the clock spring.

A quick-acting, toggle operated, brush type switch unit with arcing tips is used. It cannot reverse the operating program. This switch has a wiping contact feature and is securely locked in its closed position. It is a double-pole switch which, by means of a simple jumper arrangement on the terminal block, can be converted into a single-pole switch of 25 ampere capacity on 115-230 volts.

The standard dial is designed to control either one or two complete cycles in twenty-four hours. The arms can be conveniently set for any program. They are held in place by friction only and can be shifted along the periphery of the dial opposite any time mark. If more operations per day are required, additional arms can be supplied. The program once set is revealed at a glance.

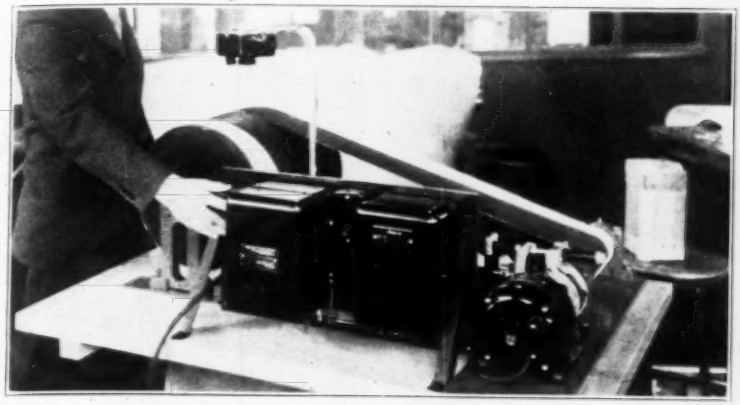
Electric Eye Sees Paper Break and Stops Printing Press

THOSE attending the annual convention of the American Newspaper Publishers' Association in the Hotel Pennsylvania, New York City, April 21 to 25, witnessed the demonstration of a model, constructed by the General Electric Company, demonstrating the ability of the photo-electric tube to detect paper breaks and "wrap arounds" on high-speed printing presses. By an ingenious arrangement of white and black stripes, simulating actual conditions on the press, the model showed how the press could be stopped whenever a break occurred in the paper or whenever a wrap-around occurred following a break.

The photo-electric unit consists of a small bulls-eye focusing a beam of light on a traveling belt (representing the sheet of paper) or the blanket cylinder of the press, and a photo-electric relay which picks up the reflected light and governs the action of the mechanism. White stripes on the belt represent the paper and black stripes represent a break in the paper, just as in actual operation a break in the white paper causes a dark space to appear where the paper was. Conversely, the black portion of the blanket cylinder represents the normal condition of no paper and the white portion, the paper which gathers on the cylinder when a wrap-around occurs.

When operating from the paper sheet, the reflection of the white sheet keeps the relay in normal condition and nothing happens, the press functioning as usual. When a break occurs, the interruption of the white light actuates the photo-electric relay and causes the control devices to stop the press.

In the case of a wrap-around, when the relay is actuated, the control devices stop the press and at the same time cause a cutting knife to rise and break the paper. Thus paper is pre-



vented from accumulating on the blanket cylinder.

In an actual application of the equipment which this model demonstrated, two photo-electric equipments would be used, one to function when the paper breaks and the other to prevent damage from wrap-arounds. The latter condition is dangerous as it may seriously injure the press machinery which means the expenditure of considerable money for repairs and also results in a loss of time. In the model, a single unit was employed, being swung around to different positions and set for either of the two conditions.

Universal High-voltage Testing Set

(American Transformer Co.)

A HIGHLY accurate testing set of unusually flexible design is found in the AmerTran Type TS-15A which has just been announced by the American Transformer Company. This apparatus is ideally suited for light testing in either the factory or laboratory where potentials from 500 to 20,000 volts at 1 kva. are required. It is being used successfully in making accurate dielectric strength measurements on materials such as paper, tape, compound, varnished cambric, condensers, and insulation in small apparatus.

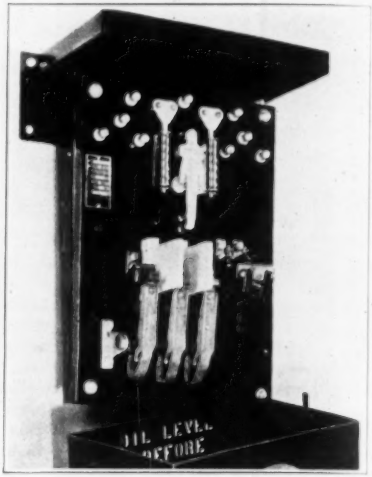
The new AmerTran testing set operates from standard 110-volt, 60-cycle circuits and contains a special air-cooled testing transformer with a four-section secondary winding which permits of obtaining three different voltages at full output—5,000, 10,000 and 20,000. In addition the equipment includes a wire-wound potentiometer for adjusting the voltage to any value between zero and maximum, the exact value being indicated at all times by a precision double-range voltmeter connected to a special winding on the transformer. For protection against damage due to overload a quick-acting circuit breaker is provided.

AmerTran Type TS-15A is completely housed in a compact metal case on the front of which is mounted a bakelite panel containing all operating controls. The eight high-tension terminals are brought out through porcelain bushings mounted on the top of the case and a socket at the side provides a convenient means for connecting the device with the power circuit. The equipment includes connection cord and "jumpers" for connecting secondary sections in series, parallel, or series-parallel.

Oil-Immersed Thermaload Starter

(Monitor Controller Co.)

This starter consists of a standard magnetic contractor mounted on a panel with a thermal relay and enclosed in an oil-tight box. The oil level is such as to completely immerse the contactor and the contacts of the relay. The thermal elements are above the oil level.



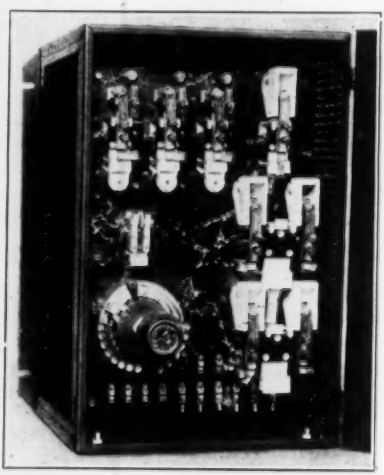
This starter gives positive protection to polyphase and single-phase motors both while starting and while running. It permits a full-voltage, full-current and full-torque start and yet protects the motor from harmful overload.

In addition to the usual overload protections, this starter will disconnect the motor if the voltage fails or drops excessively. It will prevent damage to polyphase motors from running single-phase, in case one of the phases goes dead, thus over-loading another phase.

Printing Press Controller

(Monitor Controller Co.)

THIS controller is of the push button reversing type and performs the following functions: start, jog forward; jog reverse; run at slow speed; run at preset speed, and dynamic brake-stop. Each one of these functions is under definite control and yet automatically coordinated with all other functions. The complete system in its application to printing, lithographic and gravure presses consists of a controller, one or more operator's stations and, when required, a slow-down or trip station. The most complete operator's station is equipped with only two buttons and two thumb levers.



The panel with resistor is built as a unit and enclosed in a ventilated cabinet from which it can easily be removed by taking out four bolts and disconnecting the outside leads.

The resistor bank includes the three standard Monitor Resistors. All units have constant resistance at all temperatures, therefore speed settings are unaffected by frequency of starting or by room temperature.

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DYNAMOMETER. Bulletin 500-A describes and illustrates the Gulley tractor dynamometer for use by tractor manufacturers, farm implement manufacturers and others. J. B. Hayes Company, Urbana, Ill.

HOMO NITRIDING FURNACE. Circular 220-G describes the Homo Nitriding Furnace for studying the effect of ammonia on metals. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

TESTING EQUIPMENT. Circular No. 1131 describes the AmerTran High-Voltage Test Set-Type TS-15, a flexible instrument for all kinds of light testing. Circular No. 1132 describes AmerTran Portable Equipment for Testing Oil—Type TS-6, a compact instrument for use in the field. The American Transformer Co., 178 Emmet St., Newark, N. J.

VIBRACORDER. Form No. A-248 describes and illustrates the Vibracorder which records the operation of commercial vehicles and machinery, showing running time and idle time. Ohmer Fare Register Co., Dayton, Ohio.

EXPERIMENTER. Vol. 5 No. 10, March 1931 of this publication contains article, Modulation Measurements on Broadcast Transmitters, by W. N. Tuttle. General Radio Company, Cambridge A, Mass.

THE GRAPHIC. No. 331 of this publication contains article, Cutting Costs, by Walter W. White. Esterline-Angus Co., Indianapolis, Ind.

GAGE. Circular No. 104 describes a mercury column gage used for accurate measurement of low pressure or vacuum. Amthor Testing Instrument Co., Inc., 309 Johnson St., Brooklyn, N. Y.

MOISTURE METER. Bulletin 1028 describes a moisture meter used to sort out wet stock and indicate moisture content accurately. C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y.

ELECTROMETER. Bulletin No. 330 describes and illustrates the Compton Quadrant Electrometer for accurate electrostatic measurements. Rubicon Company, 29 North Sixth St., Philadelphia, Pa.

RELAYS. Bulletin 81,000 describes magnetic relays for A. C. and D. C. current—with 2-wire and 3-wire control. Ward Leonard Electric Co., Mount Vernon, N. Y.

RADIO TRANSMITTER. A pamphlet entitled, A Low Cost Push-Pull C. W. Transmitter, by George Grammer. National Company, Inc., Malden, Mass.

MEDICAL MICROSCOPES. A pamphlet describing two new microscopes, one for physicians' and one for medical students' use. Spencer Lens Co., Buffalo, N. Y.

BINOCULAR MICROSCOPES. A circular illustrating Nos. 55 and 56 binocular microscopes. Another circular describing a research microscope No. 7 which is fitted with inclinocular body. Spencer Lens Co., Buffalo, N. Y.

COMBUSTION CONTROL. A circular identified as Feature No. 18 describes how economical operation is simplified by ease of changing ratio of fuel and air. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

POTENTIOMETER CONTROL. Folder F 122-P describes anticipatory control which eliminates manual adjustments of the by-pass valve. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

BROADCAST RECEPTION. A pamphlet entitled, The National M. B. 30, A DeLuxe Broadcast Tuner, by James Millen, M. E. and Glenn H. Browning, M. S. National Co., Inc., 61 Sherman St., Malden, Mass.

PORTABLE HARDNESS TESTER. A folder describing a portable hardness tester simple in operation, time and labor-saving, for many testing uses. Industrial Apparatus & Instrument Co., Inc., 239 Springfield Ave., Newark, N. J.

ELECTRIC TIME SWITCH. Bulletin ZWE illustrates and describes an electric time switch for off-peak control, suitable for billiard, sign, store window, flood, traffic, apartment hall, railroad station and yard lights, etc. R. W. Cramer & Co., Inc., 67 Irving Pl., New York, N. Y.

TEMPERATURE REGULATION. Catalog No. 1 (A. I. A. File No. 30-F-2) describes Stat-Amatic system of temperature regulation for all types of heating plants using any kind of fuel in all types of buildings. The Stat-Amatic Instrument & Appliance Company, Hartford, Conn.

TYCOS INSTRUMENTS. Part 1, 1931 edition of the Tycos Power Plant Catalog includes industrial thermometers, recorders, pressure and vacuum gages and regulators for temperature and pressure. An up-to-date diagramatic layout shows the application of these instruments throughout the power plant. Taylor Instrument Companies, Rochester, N. Y.

SLIDE RULE. 4 page leaflet describing the Rotarule, a new circular slide rule. J. R. Dempster, 2204 Glen Ave., Berkeley, California.

Continued on next page

RECORDING AMMETERS. Bulletin No. 374 describes triplex recording ammeters, which facilitate keeping balanced condition in polyphase circuits. The Bristol Co., Waterbury, Conn.

GAS SERVICE JOURNAL. Vol. V, February 1931, No. 2 of this publication contains the following articles: "Recent Developments in Liquefied Petroleum Gas Systems," by W. G. Watkins; "Gas Industry" by Constance Wilson, "A New Method for Determining Gas Velocities;" and "A Review of Developments in Gas Measurement and Regulation for the Year 1930" etc. March, 1931 issue contains the following articles: Liquefied Petroleum Gases, Our Mutual Problem; Southwestern Gas Measurement Short Course, etc. Pittsburgh Equitable Meter Co., 400 Lexington Ave., Pittsburgh, Pa.

SURVEYING INSTRUMENTS Circulars showing items of interest to the engineer and surveyor in regards to surveying instruments and accessories. Brandis & Sons, Inc., 754 Lexington Ave., Brooklyn, N. Y.

REMODE READING PRESSURE GAGE. Bulletin No. 70 describes and illustrates power type pressure devices explaining how the dead weight tester principle is combined with a hydraulic torque amplifier and a Selsyn motor system of long distance transmission. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.

AUTOMATIC CONTROL. Catalog No. 8008 contains data on automatic controls for temperatures, pressures, flows, liquid levels, and other vital process operating factors. 48 pages and 46 illustrations. The Brown Instrument Company, 4482 Wayne Ave., Philadelphia, Pa.

WEIGHTOGRAPH. A portfolio containing a complete list of stock charts. Twenty-seven charts are reproduced in actual size. The Howe Scale Co., Rutland, Vermont.

STABILIZER. Bulletin 175 is a preliminary description of a new and original method of controlling temperature, pressure or flow. The Foxboro Company, Foxboro, Mass.

COLORIMETER. A circular describing S. D. C. Colorimeter for determining pH. Rascher & Betzold, 829 Orleans St., Chicago, Ill.

FREQUENCY CONTROL. Circular 9851i describes an automatic frequency controller and automatic frequency recorder for regulating instantaneous frequency. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

EXPERIMETER. Vol. 5 No. 9 of this publication contains an article entitled Attenuation Measurements on Telephone and Telegraph Lines, by J. W. Horton. General Radio Co., Cambridge A, Mass.

HEAT TRANSFER. A booklet entitled Heat Transfer in Laboratory Ovens, which presents the principles of good oven design—as an aid to the selection of proper equipment. Freas Thermo-Electric Company, Irvington, N. J.

PHYSIOLOGICAL APPARATUS AND INSTRUMENTS. A pamphlet containing illustrations of a number of redesigned pieces of standard apparatus. Phipps & Bird, Inc., 140 Virginia St., Richmond, Virginia.

TECHNICAL INSTRUMENT BULLETINS. Vol. 3 No. 1 of this publication contains an article entitled, Scientific Principles of Disinfection, by P. Hofmann. Vol. 3 No. 2 contains the article, Optical Instruments in Modern Hospitals and in Medical Practice, by Erich Pestel. Vol. 3 No. 3, On the Performance of Modern Achromatic Objectives, by Prof. Dr. Max Wolff. Emil Busch Optical Co., Ltd., 37 Hatton Garden, London, E. C. 1, England.

WAVE RECEPTION. A pamphlet on short wave reception with a National "SW5" Thrill-Box. The Jackson Research Laboratories, Jackson St., Malden, Mass.

COUNTER. Catalogue 30 on The Predetermining Counter, which stops the machine, lights a light or rings a bell. Veeder-Root Inc., Hartford, Conn.

INSTRUMENTS, RELAYS, & ELECTRONIC DEVICES. Catalogue 211 is a 136 page publication describing electronic devices, including photo-electric tubes, grid-glow tubes, light relays, and other devices. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

WATER WORKS JOURNAL. Vol. XXIII No. 3, March, 1931 issue of this publication contains the following articles: New Water Works for Tampa, Fla.; Public Water Supplies in British India; Hydraulically Speaking; and Southeastern Section of American Water Works Association to Meet at Columbia. Vol. XXIII No. 4, April, 1931 issue contains the following articles: Shallow Wells Solve Water Supply Problem for Semi-Arid Wyoming Town; The Story of Clarksburg's Water System; Hydraulically Speaking; Changing from a Flat Rate to a Meter Basis, etc. Pittsburgh Equitable Meter Co., 400 Lexington Ave., Pittsburgh, Pa.

STREET LIGHTING. Publication No. A-1206 entitled, Bringing Cities Out of the Twilight Zone, contains 30-page discussion of modern street lighting by L. A. S. Wood. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

BUILDING LIGHTING. Publication No. 1204, 23 illustrated pages discussing present-day principles and practice in the interior lighting of modern buildings. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

FLOODLIGHTING. Publication A-1208, 23 pages describing advantages of floodlighting; gives recommendations useful in making floodlighting installations. Photographs showing floodlighted office buildings, monuments, towers, industrial plants, residences, athletic fields, etc. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

ANNEALING FURNACE. Form 112, describes how continuous annealing furnace cuts production costs and improves product. Surface Combustion Corp., Toledo, Ohio.

INDICATORS AND METERS. A circular on Tanner Instruments, which indicate and record variations in liquid levels, vertical movements of gas holders, position of valves and sluice gates or any straight line or angular motion, at any distance from the point of measurement. Wallace & Tiernan Products, Inc., Belleville, N. J.

THE LABORATORY. Vol. 3 No. 4 contains the following articles: Michael Faraday, Electro-Chemist; A Notable Notebook Notation; Vitamins-A Test for Them; A New Centrifuge Takes Honors in the Junior Class; The Right Wright Stain, etc. Vol. 4 No. 1 contains the following: A Laboratory Apparatus Controls a Billion-Dollar Industry; By an Embryo Scientist; Shock Absorbers for Graduated Cylinders; How Hot is Cherry Red; Putting the Vacuum to Work, etc. Vol. 4 No. 2 contains, Berzelius; Another Advancement in Metallography; Doctoring Metals Welds, etc. Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.

OPEN-HEARTH CONTROL. A four-page folder reprinted from October, 1930 issue of Iron and Steel Engineer, which describes a method for automatic reversal of open-hearth furnaces. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

RADIO PRODUCTS. A 12-page pamphlet illustrating and describing radio products. Prices of the various parts are also listed. National Company, Inc., 61 Sherman St., Malden, Mass.

CRYSTALLOGRAPH. A booklet describing X-Ray Crystallograph for the analysis of substances having crystalline structures. Adam Hilger, Ltd., 24 Rochester Pl., Camden Rd., London N. W. 1, England.

CRYSTAL ANALYZER. A leaflet entitled, "The Cubic Crystal Analyser." Adam Hilger, Ltd., 24 Rochester Pl., Camden Rd., London, N. W. 1, England.

BUYERS' GUIDE

Of instruments and devices for measurement, inspection or control

you are unable to find what you require in the Buying Section of INSTRUMENTS—write Information Section, Instruments Publishing Co., Pittsburgh, Pa. Give complete information of requirements.

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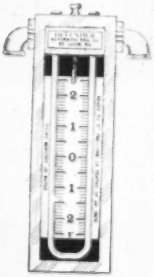

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CURRENT LITERATURE REVIEW

Abstracts on instruments and devices for measurement, inspection and control

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INSTRUMENTATION, GENERAL

200 Years of Thermometry, a Memorial to the Invention of the Barometer and Thermometer (200 Jahre, ein Denkblatt zu der Erfindung des Barometers und Thermometers). Steencken. Allg. Vermessungsnachrichten vol. 42 No. 52, Dec. 24, 1930, pages 820-821.

Recalls briefly the circumstances of the inventions and their mathematical relations and practical forms and uses.—Ha.

Instruments Aid in Operating Gas Producers Economically. Jay S. McClimon. Steel, Oct. 9, 1930, pages 54, 56, 58.

Discusses gasification in the producer and cites many practical details of producer practice. Saving of fuel in a gas-producer can be accomplished as it is done in the boiler-plant by equipping the units with instruments which will give a reliable and continuous record of operation. As the temperature of the gas leaving the producer is a direct indication of its quality, every gas-producer should be equipped with a pyrometer.—M. S.

Heat Control in a High Pressure Boiler Plant. (Waermetechnische Ueberwachung in einer Hochdruckdampfanlage.) Siemens-Zeitschrift, Vol. 10, November 1930, pages 611-612.

The equipment of heat control of the Municipal Power Station at Vienna is described.—G. N.

Open Hearth Furnace Heat Control Equipment at the Rasselstein Steel Plant (Die wärmetechnische Messanlage an den Siemens-Martin-Oefen der Rasselsteiner Eisenwerke). K. H. Moll. Siemens Zeitschrift, Vol. 10, Dec. 1930, pages 615-620.

Illustrated description of all instruments for supervising the heat efficiency of the Rasselstein open hearth plant. All recording instruments are installed in a special supervision room.—G. N.

Measuring, Signalling, and Control Installations in the Blast-Furnace Plant Essen-Borbeck of Fried. Krupp (Die Mess-, Signalund Regelanlagen des Hochofenwerks Essen-Borbeck der Firma Fried. Krupp Aktiengesellschaft). P. Ostwald and W. Liesegang. Simens-Zeitschrift vol. 11, No. 2, Feb. 1931, p. 49-56.

Detailed description of location and kind of instruments used in this new plant for indicating, recording, and metering gases and air in the operationof two blast-furnaces of 600 t. per day; there are 31 places where instruments are placed which all are wired for remote reading in the control observation room.—Ha.

Progress in the Iron and Steel Industry in 1930—(Report). J. D. Keller, F. C. Biggert, Jr., A. C. Dinkey, W. N. Flanagan, C. H. Herty, Jr., John C. Long, Arthur G. McKee, Richard Moldenke, H. S. Rawdon, L. F. Reinartz, W. C. Ross, W. B. Skinkle, George T. Snyder and F. N. Speller. Mechanical Engineering, Vol. 53, January 1931, pages 48-50.

It is found that considerable progress has been effected in spite of adverse influences. One bright feature of the situation is the opening of research departments in a number of steel plants. The Executive Committee notes especially the progress of Instrumentation. The serious application of automatic control to open-hearth furnaces has just begun. The use of metering devices and of automatic control has made the prevention of leakage into and out of the checkers, an absolute necessity. In the rolling mill, the demand for greater accuracy and closer tolerances has led to the use of pyrometers which measure the temperatures at all points in the length of the bar while it is being rolled. In furnaces, atmosphere control developments are noted, and complete automatic control has already been achieved.—M. F. B.

Motor-Vehicle Performance Indicating and Recording Devices. (1) Paper by Carl W. Stocks. S. A. E. Journal, Vol. 27, November 1930, pages 528-540. (2) Discussion of Carl W. Stocks Paper. S. A. E. Journal, March, 1931, pp. 365-377.

The author points out how instruments can be used by all classes of motor-vehicle operators. Instruments intended as a check on operation and designed to furnish definite information through the medium of charts or tapes are commented upon, as well as devices that are primarily designed to assist the driver in more intelligent vehicle-operation. Several types of available recording devices are analyzed. The reliability of speedometers in general is doubted, but the author states what other motor-vehicle carriers are doing to maintain conventional-type speedometers in reasonably good working order. He urges development of an accurate engine-revolution counter and rating of engine performance by engine revolutions. New instruments and applications of existing devices are described and discussed by representatives of instrument manufacturers and motor-coach operators. Standardization of instruments is stressed, as well as the need for a standard to measure their performance. Speedometers are criticized and defended by several speakers. Instruments that would function automatically to regulate the speed of the vehicle, especially when rounding a curve, are mentioned as a desirable addition to the motorcoach instrument-board.—M. F. B.

Trends in Instrument Grouping. Editorial article. Power Notes (House organ, Diamond Power Specialty Corp.) November-December, 1930, page 8.

Discussion of the two extremes: every instrument located nearest point of application, and all instruments centralized. Only the power plant is considered.—M. F. B.

Testing—The Guide to Better Production. (Editorial article). Electronics, February, 1931, pp. 496-497.

This editorial includes a list of 66 instruments and apparatus and is illustrated by a full-page flow sheet of production tests and design tests in the electronic manufacturing industries.—M. F. B.

Realizes Economies Through Automatic Regulating Devices. Francis A. Westbrook. Industrial Power, March, 1931, pages 37, 46, 51.

Where and how the Ferry Hat Company effected savings in process steam, fuel, and city water through Instrumentation.—M. F. B.

CONDENSER LEAKAGE RECORDERS
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CONDENSERS—Electrical
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Minneapolis Honeywell Co.
Tagliabue Mfg. Co., C. J.
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Automatic Temp. Control Co.
Bristol Company
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Minneapolis-Honeywell Co.
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Taylor Instrument Companies

Pyrometer
Bristol Company
Brown Instrument Co.
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Illinois Testing Labs., Inc.
Leeds & Northrup Co.
Tagliabue Mfg. Co., C. J.
Taylor Instrument Companies

Rate-Volume
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Recent American Instruments for Measuring and Automatically Regulating Temperatures (Neuzeitliche Amerikanische Apparate zum Messen und zur selbsttatigen Regelung von Temperaturen). H. Illies. Die Messtechnik vol. 6, No. 11, Nov. 1930, page 299.

Short illustrated description of measuring methods and instruments.—Ha.

A New Instrument for Measuring Low Temperatures (Ueber ein neues Instrument fuer Tieftemperaturmessung). Die Messtechnik, Vol. 7, No. 2, Feb. 1931, page 55-56.

Description of a moving coil instrument in connection with an iron-constantan thermocouple for temperatures of $-200°$ to $+50°$C., built by Apparate fabrik Hans Klinkhoff, Wien. Each division of the scale corresponds to $1x10^{4}$ volt or $4.57x10^{2}$ amp; resistance of instrument is 220 ohm. Six different couples can be switched in turn.—Ha.

Temperature Instruments at the Open-Hearth Furnaces of the Rasselstein Iron Works (Die waermetechnische Messanlage an den Siemens-Martin-Oefen der Rasselsteiner Eisenwerke). K. H. Moll. Siemens-Zeitschrift, Vol. 10, No. 12, Dec. 1930, pages 615-620.

The instruments in this plant permit a continuous supervision of the melting operations. The arrangement of nickel-nickel-chromium thermocouples in the furnaces, gas producers, and waste-heat boilers; and the central supervisory office, are described in detail and illustrated.—Ha.

A New Alternating Current Quotient-meter with Movable Iron Core for Thermal Control (Ein neuer Wechselstrom-Quotientenmesser mit Dreheisenmesswerk "Ringeisenmesswerk" für wärmetechneische Ueberwachungsanlagen). W. Geyger. Elektr. Zschr. Vol. 52, No. 9, Feb. 26, 1931, page 286-287.

This instrument is to take the place of the transmitter using a source of D. C. current so that if only A. C. is available no special rectifier is required. The movable ring is composed of transformer steel stampings between two circular stationary coils 180° apart. As it is of the induction type it has the advantage against the D. C. instrument in not having any leads to the moving part. It is suitable as well for indicating and recording purposes and for remote control. The manufacturer is W. H. Joens & Co., Duesseldorf.—Ha.

Surface Pyrometer of the Pyro Works. Dr. Rudolf Hase (Oberflächenpyrometer des Pyro-Werks Dr. Rud. Hase). El. Zsch. vol. 52 No. 3, Jan. 15, 1931 page 85.

A portable instrument of bi-metal strips for temperatures up to 400°C is placed against the parts to be measured. Fluctuations in surrounding temperature are automatically connected by another bi-metallic spiral. The instrument is direct reading.—Ha.

Color Pyrometry (Zur Farbpyrometrie). G. Naeser. Nitteilungen Kaiser Wilhelm Institut für Eisenforschung, Vol. 12, 1930, Report 163, pages 299-316; Stahl und Eisen, Vol. 50, Dec. 18, 1930, pages 1788-1789.

This is the last of Naeser's papers on the color pyrometer. After reviewing the various methods which can be used in measuring temperatures by means of measuring the color of emitters, 2 of these methods were carefully examined. The first method, as previously described (Stahl und Eisen, Vol. 49, 1929, pages 464-466), is based on the comparison of colors; the other measures the brightness of the colors. Both methods are described and the suitability investigated and established. Color pyrometer offers large advantages.—G. N.

The Influence of Emissivity on the Determination of the Temperature of Liquid Iron (Einfluss des Emissionsvermögens auf die Temperaturmessung am flüssigen Eisen). Rudolf Hase. Archiv für Eisenhüttenwesen, Vol. 5, Nov. 1930, pages 261-264; Stahl und Eisen, Vol. 50, Dec. 25, 1930, pages 1813-1814.

The paper summarizes the results of comparative temperature measurements taken on liquid cupola Fe with a thermocouple and an optical pyrometer (system Optix) respectively. In addition to these temperature measurements, moving pictures were taken of the sighted surface of the liquid metal. In comparing the true temperatures (thermocouple) with the relative temperatures (optical pyrometer), the result is that the readings with the optical pyrometer should not be taken in the middle part of the spout of the cupola. The true and relative temperatures were found to be satisfactorily concordant only when the readings were taken when the jet of metal pours into the ladle. In 20 additional laboratory tests, the emissivity of oxidized and non-oxidized metal surfaces was determined. In the temperature range from 1250° to 1600°C., the error of temperature of the non-oxidized metal surface continuously increases from 85° to 140°C. The similar curve of the temperature of the oxidized surface has a constant course up to 1400°C., but splits at this temperature into 2 branches. Between 1250° and 1600°C., the emissivity of the non-oxidized Fe is in the average 0.44 ± 0.03; of the oxidized Fe, 0.95 ± 0.05. The paper, furthermore, contains temperature correction data for liquid Fe of various compositions.—G. N.

New Temperature Regulator (Un nouveau régulateur de température). Léon Dubar. Revue Générale de l'Electricité, Aug. 23, 1930, pages 283-287.

Discusses first the usual bimetallic strip type of thermostat most commonly used in small electric heating applicances. With this system, occasional important variations in temperature take place. Author's modification consists in placing near the bimetallic thermostat an auxiliary resistance in series with the main current. This gives an almost uninterrupted current and a regulation similar to that obtained with continuous action regulators. Gives theory, numerical examples, and modifications for different purposes.—M. S.

New Method of Measuring Temperature. Heat Treating and Forging, Oct. 1930, pages 1327-1328.

Describes the "Pyrovisor," and principles underlying its use. The instrument is a color pyrometer based on the comparison of the intensity of two monochromatic radiations. Shape of the meter is that of a slide-rule, and its weight is only 5 oz.—M. S.

Radiation Thermostat. Electrical Review, Aug. 22, 1930, page 319.

Describes "Morganite" radiation thermostat, introduced by the Morgan Crucible Co., Ltd., for the automatic control of electric radiators. Based on the rate of heat loss from a heated body, which consists of a black copper sphere which, provided the surrounding conditions are such as to comply with the required conditions of comfort, when heated internally by a small input of 3-10 watts, will be held at the same temperature as one's clothes. Equipment consists of the thermostat proper and one or more relays.—M. S.

Radiant Heat from Radiant Heaters and Its Measurement. F. E. Vandaveer. (American Gas Association Testing Laboratory, Cleveland, Ohio). Industrial & Engineering Chemistry, June 1930, pages 596-600.

Presented before the Division of Gas and Fuel Chemistry at the Atlanta Meeting of the American Chemical Society, April 1930. The thermopile and its calibration, the method of testing radiant heaters for radiant efficiency used at the American Gas Association Testing Laboratory are described. Tests show that: 1) the thermopile is capable of measuring radiant heat as emitted by a radiant heater; 2) the method of test is accurate to within $\pm 1\%$ of the true reading; 3) the diathermacy constant obtained is consistent and may be accurately obtained.—M. E. H.

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An Apparatus for the Determination of Melting Points. L. M. Dennis and R. S. Shelton. Journal American Chemical Society, Aug. 1930, pages 3128-3132.

The article describes an apparatus for the measurement of the melting points of substances, particularly of organic substances, up to temperatures of about 300 degrees C. A determination can be made within thirty seconds with an accuracy of about 0.25 degr. The method employs a copper-constantan thermocouple and a potentiometer.—M. E. H.

Temperature Regulator Shifts Automatically. Electrical World, Vol. 97, Jan. 17, 1931, page 108.

The Stat-Amatic Instrument & Appliance Co., Hartford, Conn. has put out a temperature regulator for domestic and industrial heating systems. It is equipped with an electric motor-wound clock, is fully automatic in operation and has a dual thermostat which maintains the desired temperature automatically.—W. H. B.

A Precision Cryostat with Automatic Temperature Regulation. R. B. Scott and F. G. Brickwedde. Bureau of Standards Journal of Research, March 1931, pages 401-410.

A cryostat, which is an apparatus for maintaining constant low temperatures, has been designed and constructed for use in the temperature range from 0° to −170°C. In this range the temperature can be easily adjusted to any desired value and can be automatically maintained constant to within 0.001°C. It can also be used for maintaining temperatures at the boiling points of liquid oxygen, nitrogen, or air.

A Thermostat Regulator. Elliot Q. Adams. The Review of Scientific Instruments. March, 1931, pages 187-188.

A thermostat regulator has been constructed with a tungsten-mercury contact in hydrogen permanently enclosed in glass. Adjustment is made by a mercury-tight tungsten plunger in another 2 mm capillary, one complete turn of the micrometer head advancing the plunger approximately 1 mm, equivalent to 0.08°C. The contact breaks approximately 1 milliampere which actuates relays controlling the heating circuit of one ampere, 110 volts A. C. The regulator kept a 50-liter water thermostat constant to ±0.002°C for an hour, with a 5-minute regulation cycle. With an auxiliary heater close to the regulator and the regulation cycle less than 1 minute, the temperature variation was less than ±0.001°C over a period of three hours.

Pyrometers—Where shall we Put Them. A. N. Lindberg. Factory and Industrial Management, February, 1931, page 252.

A plea for correctly locating pyrometers in heat-treating plants. 2 illustrations.—M. F. B.

HEAT & COMBUSTION

The Heat Formation of Zinc Oxide. Charles G. Maier. Journal American Chemical Society, June 1930, pages 2159-2170.

A calorimeter of some unusual features, including the use of tantalum and bakelite for those portions subject to corrosion, an ethyl bromide "boiler" for cooling, copper resistance thermometer and heating coil of manganin. Diagram is given.—M. E. H.

A Calorimetric Determination of Thermal Properties of Saturated Water and Steam From 0 Deg. Cent. to 270 Deg. Cent. Paper No. FSP-52-28. N. S. Osborne, H. F. Stimson, and E. F. Fiock. Trans. A. S. M. E., Sept.-Dec., 1930, pp. 191-220.

A description is given of the method, apparatus, measurements, results, and formulations involved in the work on steam which has been completed to date at the Bureau of Standards. The method has been developed in accordance with the principles set forth in a rigorous analysis of the thermodynamic processes involved in a change in state of a saturated fluid. The apparatus has been designed and built to provide a means for accurately controlling, observing, and accounting for the amount, the change in state, and the change in energy of a sample of water. It is described in minute detail with 11 figs. The observations have been carried out as a systematic series of experiments in the range from 0 deg. cent. to 270 deg. cent. (to 55 atmospheres pressure) yielding as a result the values of three characteristic thermal properties of the saturated fluid. The formulation of the results establishes the values of heat content, latent heat, and entropy, and constitutes an exhibit of the thermal behavior of saturated steam in the region covered by the experiments. The results are assembled in a coherent, consistent table of the properties of steam, available as a foundation for a more complete steam table. It is found that, when reduced to a uniform basis, after critical study and analysis, most of the source data on saturated steam are in a satisfactory accord. Worthy of mention are the 14 tables, of which one takes up more than four 7 x 10 inch type pages. All in all, a monumental piece of work.—M. F. B.

Calorimetry of a Fluid. Paper No. FSP-52-29. Nathan S. Osborne. Trans. A. S. M. E., Sept.-Dec., 1930, pp. 221-229.

A rigorous analysis of the thermal processes involved in the change of state of a saturated fluid shows that four types of calorimetric processes each yield values of a characteristic thermal property of the fluid. This group of calorimetric properties may be used to formulate the thermal behavior of the fluid in terms of familiar and convenient properties within the range of the experimental possibilities. The principles of a calorimetric method of determining the thermodynamic characteristics of a fluid are outlined. The method has been developed at the Bureau of Standards and used in the determinations of the properties of saturated water and steam, published simultaneously and reviewed above. This paper supplements that report and furnishes the theoretical groundwork for the experimental work. The results of the analysis have been used as a guide in developing a systematic experimental project which has resulted in the determination of an important group of properties of saturated steam. The systematic method of observing the thermal behavior of fluids, here given, is an important contribution to heat engineering.—M. F. B.

A Review of Calorimetric Measurements on Thermal Properties of Saturated Water and Steam. Paper No. FSP-52-30. Ernest F. Fiock. Trans. A. S. M. E., Sept.-Dec., 1930, pp. 231-242.

Review was prepared to assemble data now available on calorimetric determination of thermal properties of saturated water and steam, and to reduce them to a uniform basis for comparison. After careful analysis of the reports which have appeared in the literature, attempt is made to point out some possible causes for variation among recorded results. Wherever it seemed desirable a thermodynamic interpretation of the experiments is given, and in a number of cases the data have been recalculated. By these means the agreement among the various determinations has been improved in several instances. This assembly of results presented on a uniform basis may serve as an aid to future International Steam Table Conferences in the choice of base values and tolerances for the International Skeleton Tables. By means of deviation charts, experimental values for the heat content or enthalpy of the saturated liquid and for the latent heat are exhibited and compared. The agreement is in general quite gratifying. Several modern steam tables are compared graphically with one another and with the Buteau of Standards experimental results on the thermal properties of the saturated liquid and vapor. A marked improvement in the tables is evident with the increase in scope and the reliability of the basic experimental data. 6 charts, 9 tables.—M. F. B.

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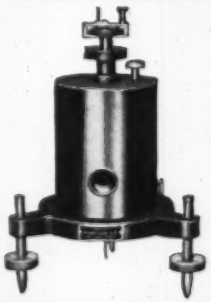

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Open-Hearth Combustion. W. P. Chandler, Jr. Proceedings of Engineers' Society of Western Pennsylvania, Vol. 46, October, 1930, pages 241-255; discussion 256-263.

The paper points out various factors concerning combustion which have to be considered if proper economical operation of a furnace is to be obtained. Importance is attached to furnace regulation and automatic regulation is discussed.—M. F. B.

The Purpose and Characteristics of the Air-Flow Mechanism of a Boiler Meter. Paper No. FSP-52-37. W. G. Lauffer. Trans. A. S. M. E., September-December, 1930, pages 313-329.

The author is Testing Engineer of the Hudson Avenue Station of the Brooklyn Edison Co. In the long discussion, views were expressed and facts presented not only by other power plant engineers but on behalf of the Bailey Meter Co. A detailed study is made of the air flow mechanism of the Bailey Meter, the proper operation and calibration of which the author states "had not apparently been properly understood nor completely developed. However, the detailed study of the purpose and characteristics of the mechanism, which is described in this report, has resulted in an indicator of combustion efficiency that is reliable within very close limits." Part I relates the difficulties that had been encountered in setting the boiler meters for predetermined air requirements and the first steps that were taken to remedy these difficulties. This part also describes the development of a method of calibrating the meter against diffierential, the "deadweight check," and presents the computations involved. Part II includes the fundamental mathematics for the derivation of the proper displacer contour. This is expanded in the Appendix. Part III is a discussion of the determination of the desired characteristic of total air with respect to rating. This part also includes the development of the proper technique of flue-gas sampling and the demonstration of the necessity for gas-sampling lines on both sides of the boilers. Part IV describes in detail the routine that has been developed to insure continuous maintenance in calibration of the air-flow mechanism, the necessity of which is a fundamental prerequisite to a consistently minimum stack loss. Practical results reported: Maintenance of the stack losses at a desirable low level has resulted, because the meters are now accepted as giving a true indication of the percent total air. Before this work was done, a usual excuse for operating with the meter pens apart was that the meter was not set correctly. While the meters were not always incorrect, they were so in a sufficient number of cases to cause them to be regarded as unreliable. Now, however, the boiler-meter indication is correct within limits of 1 to 2 percent of total air. From the point of view of calibration and adjustment of the meters, an equally great advance has been made. Maintenance of meters in proper calibration has been rendered less laborious as well as more effective. The ability to use the record of radii changes as a check on the condition of the exterior of the boiler tubes and baffling also represents an advance. The proper installation of meters in any extension to the boiler house is prepared for. Knowing the probable draft loss through the boiler at any rating, it is possible to determine in advance the characteristics of the air-flow mechanism for that application. No attempt has been made to determine the monetary equivalents of these results. All in all, packed with practical information.—M. F. B.

The Characteristics of an Explosive; Properties Determined by Combustion in a Closed Chamber M. E. Burlot (Translated by Major Donald Armstrong, Ordnance Dep't, U. S. Army). Army Ordnance, January-February, 1931, pages 283-286.

The author is Chief Engineer of the Corps des Poudres, Recording Secretary of the Scientific Commission of Explosive Materials and Prize Winner of the Institut de France. The U. S. Army evidently attaches a great deal of importance to this paper, which discusses the experimental methods of determining some of the mechanical properties of an explosive by means of combustion in a closed chamber, and describes the characteristics of the instruments and apparatus used for this purpose in the Laboratory of the Commission Scientifique des Substances Explosives at Sevran. The data sought are such as affect the mechanical or ballistic functioning of explosives. Aside from the phenomena of sensitiveness and velocity of detonation the investigation usually includes the determination of three properties: 1. P(t), the pressure developed as a function of time by the combustion in a volume v of the weight ω of explosive; 2. V_0, the specific volume of the explosive or volume of the gaseous mixture (permanent and impermanent gases reduced to 0°C. and 760 mm pressure) resulting from the combustion of a unit weight of explosive; 3. T, the average absolute temperature of the gases at the moment of maximum pressure. The three set-ups of instruments described are: 1. The pressure gage éprouvette of M. Vieille, which is a special bomb provided with crusher gages and recording instruments; 2. The gasometer of Sarrau and Vieille for the measurement of V_0 (which had previously been described, see Mémorial des Poudres, Vol. II, pp. 137 et seq.) 3. The calorimeter of Berthelot, for the measurement of the temperatures of combustion, which is in its general plan like the Landrieu Malsallez type. A feature is the provision for extreme accuracy in thermometry together with safety, resulting in telescopic reading of the special thermometers.—M. F. B.

HUMIDITY & MOISTURE CONTENT

A New Humidity Meter on Psychrometric Principle. (Ein neuer Feuchtigkeitsmesser auf psychrometrischer Grundlage). F. Lieneweg. Zeitsch. fur Feinmechanik und Präzision vol. 38 No. 23, Dec. 17, 1930, pages 1-7. Also Siemens-Zeitschrift, Vol. 10, Nov. 1930, pages 584-591.

Instrument is suitable for plant operation, and for remote indication and control, indicating or recording relative and absolute humidity. The mercury thermometers of usual psychrometers are replaced by resistance thermometers, one of which is the wet-bulb. The current is measured by a cross-coil instrument so that the influence of voltage fluctuations is eliminated. The theory of this method is given. This instrument can be used over a wider temperature range than mercury thermometer instruments. It lends itself also well for the measurement of explosive gases. The accuracy is within ± 3% for 10% to 100% humidity at temperatures from −5 to +120°C. Several types for measuring humidity of air and gases are described and illustrated.—Ha. & G. N.

The Humidity in Technical Gases. Part II. Application of the Calculations of the Humidity. Part III. Examples of the Calculation (Die Feuchtigkeit in Technischen Gasen. 2. Teil: Anwendung der Feuchtigkeitsrechnung. 3 Teil: Rechenbeispiele). Feildrich Lüth. Archiv für Eisenhüttenwesen, Vol. 4, Oct. 1930, pages 185-189, Report 143, Heat Committee, Verein deutscher Eisenhüttenleute; Dec. 1930, pages 281-287, Report 145, Heat Committee, Verein deutscher Eisenhüttenleute; Stahl und Eisen, Vol. 51, Jan. 1, 1931, pages 14-16.

In continuation of the first part (Archiv für Eisenhüttenwesen, Vol. 3, 1930, pages 397-405) of this series of articles on the humidity in technical gases, the last 2 installments cover the application of the calculation as for evaporation, determination of the calorific value and the determination of the combustion temperature of humid gases. 19 examples of calculation are given in the last part, covering the calculation of the specific volume of humid gases, measurement of the quantity of gases, determination of the calorific value and calculations on gas cooling and gas drying.—G. N.

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An Electrical Method for Determining the Moisture Content of Wood. Alfred J. Stamm (Forest Products Laboratory, Madison, Wis.) Industrial & Engineering Chemistry, Analytical Edition, July 15, 1930, pages 240-244.

A simple, compact, and portable apparatus for measuring electrical conductivity is described for use in determining the moisture content of wood. With a pin type of contact the conductivity measurements can be translated directly into terms of average moisture content, not only when the moisture is uniformly distributed, but also when it is distributed according to any normal drying gradient.—M. E. H.

How to Use Thermocouples in Humidity Determination. Paul E. Demmler. Chemical and Metallurgical Engineering, March, 1931, page 169.

Practical hints. Wet-bulb thermocouple junction should be about 1 in. beyond the end of the covering of the cable, and the bare wires should be completely enclosed in the wet fabric. A potentiometer should be used.—M. F. B.

PRESSURE & VACUUM

A Micromanometer with Convenient Reading (Ein Mikromanometer mit beguemer Ablesung). A Betz Die Messtechnik, Vol. 7, No. 2, Feb. 1931, pages 37-39.

For measurements of pressures of 100 to 200 kg/m² which, as for inst. in wired-channels, must be measured with an accuracy of 1/10 to 1/20 kg/m², G. Bartels, Gottingen, has developed a manometer in which the pressure is determined by the difference in water level in two containers one of which has nine times the surface of the other. A float actuates a pointer on a frosted glass scale divided in tenths of kg. 1/100ths can be estimated.—Ha.

Average Pressure Indicator (Mitteldruckindicator) H. K. Lehr. Die Messtechnik, Vol. 6, No. 12, Dec. 1930, pages 323-326.

A novel indicator is described which indicates the mean pressures in cylinders of reciprocating engines and is independent of the number of revolutions of the machine. The principle of this method is the following: a small quantity of gas in proportion to all the pressures on the piston is taken out of the cylinder and led into the open after flowing through a capillary resistance. The pressure before the capillary resistance is proportional to the weight of the passing gas, and therefore this auxiliary pressure is proportional to the mean pressure in the engine cylinder. The theory is developed in detail. Test with 2- and 4- cycle engines have given an error of not more than ± 2½% against tests with usual indicators.—Ha.

A Balanced Diaphragm Type of Maximum Cylinder Pressure Indicator. J. A. Spanogle and John H. Collins, Jr. Technical Note 359, National Advisory Committee for Aeronautics, 7 pages mimeographed.

A balanced diaphragm type of maximum cylinder pressure indicator was designed to give results consistent with engine operating conditions. The apparatus consists of a pressure element, a source of controlled high pressure, and a neon lamp circuit. The pressure element, which is very compact, permits location of the diaphragm within ⅛ inch of the combustion chamber walls without water cooling. The neon lamp circuit used for indicating contact between the diaphragm and support facilitates the use of the apparatus with multicylinder engines. In measuring compression pressures only one reading is taken. However, in measuring maximum explosion pressures a range of pressure is read which shows the variation between individual cycles. This indicator is in current use at the Langley Memorial Aeronautical Laboratory as the most accurate available means for indicating maximum cylinder pressures.

Measurement of Rolling Mill Pressures. W. L. DeLaney. Iron Age, February 19, 1931, pages 609-611.

Describes the McCollum-Peters electric telemeter for the measurement of transient stresses and means of determining their value. Essential part consists of a pair of carbon pile resistors, mounted in metal frame in such way that their resistance is changed by the pressure. In applying the telemeter, a pressure plug is used, consisting of a cylinder of steel about 6 in. high and from 5 to 12 in. in diameter. By connecting the oscillograph in the circuit, the value of the deflection can be made at the same time. Load of housing and other parts and also actual time of pass are determined. —V. S. P.

Instruments for the Boiler House. J. W. Morris. The Instrument World, October, 1930, pages 133-137; November, 1930, pages 157-159; December, 1930, pages 181-184.

October article covers CO_2 meters; November article the theory of liquid manometers; December article draft and pressure indicators and recorders.—M. F. B.

A Simple Attachment to Ordinary U-Tube Manometers for Maintaining Constant Pressure. By J. A. Van den Akker. The Review of Scientific Instruments, November, 1930, pages 684-686.

So simple! A photoelectric cell placed at a certain height behind one leg of a U-tube. Who hadn't thought of it? But it remained for Van den Akker to do it . . . and well.—M. F. B.

Low Vacuum Pressure Control Apparatus. L. A. Richards. Review of Scientific Instruments, January, 1931, pages 49-52.

Apparatus maintains either desired negative pressure below atmospheric or desired absolute pressure down to a few millimeters of mercury. A further advantage is that only one pump is required to control pressure in any number of vacuum tanks in each of which pressure is independently controllable. Basis of method is that a vacuum higher than will be required in any of the controlled tanks is automatically maintained in one vessel by means of a mechanical pump. Then for each vacuum tank there is a U-tube having on its low pressure leg a side tube with a portion of porous clay or porcelain material readily permeable to air but not to mercury. Level of mercury inside such a porous tube acts like a control valve disc.—M. F. B.

FLOW & VOLUME

Further Measurements of Propeller Fan Characteristics. P. S. Ballif and H. L. Dryden. Bureau of Standards Journal of Research, March 1931, pages 387-399.

The characteristics of a 4-blade propeller fan 8 feet in diameter operating under conditions approximating those encountered in cooling towers have been determined for comparison with the performance of 2-blade propeller fans, thus establishing experimentally the effect of increasing the number of blades. In addition, the characteristics of a 2-blade fan 9 feet 11 inches in diameter operating in a duct 10 feet in diameter have been measured for determining the effect of modifying the conditions of installation. Each fan was tested for two conditions of operation—when the fan was operated as a blower, and when the fan was exhausting air from the duct. The results have been compared with the performance of an 8-foot, 2-blade propeller fan of approximately the same pitch/diameter ratio. The chief effect of increasing the number of blades is to reduce the speed of rotation required to meet given conditions. A faired entrance for the blower arrangement improves the performance of the fan.

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Method of Calibrating Float Steam Meters by means of Water. (Verfahren zum Eichen von Schwimmer-Dampfmessern vermittels Wassers). Ernst Claassen. Die Messtechnik Vol. 6, No. 12, Dec. 1930, page 326.

The meters were first calibrated with water and then the constant was determined which gave the quantity of steam. The quantity of water passing through the meter in unit time is to be divided by this constant to obtain steam quantities. A complete table for pressures from 1 to 16 atm. is given.—Ha.

The Accuracy of Some Water Measuring Methods. (Die Genauigkeit einiger Wassermessverfahrennen) O. Kirschmer and B. Esterer. Zeitschrift Verein Deutscher Ingenieure vol. 74, No. 44, Nov. 1, 1930, pages 1499-1504.

The authors compare results of measuring water quantities by the overflow method, vane method, salt velocity method, and salt dilution method (titration method) in open channels. The arrangements are described in detail with tables and diagrams. Results show that for none of the methods a dependence of the magnitude of the error from water velocity was formed. The range was from 0.3 m/sec. to 1.2 m/sec. The vane method with Orr vane and the salt-dilution method gave the best values. 8 references.—Ha.

Measurement of Liquid Level in Storage Tanks (Inhaltsmessung eines Lägerbehalters). Die Messtechnik vol. 7, No. 2, Feb. 1931, page 56-57.

Describes an arrangement for producing a slight pressure in an inaccessible underground tank, whereby its contents are always accurately registered on a gage glass in a convenient place. Built by R. & G. Schmolle Metallwerk A. G., Menden-Germany.—Ha.

Improved Apparatus for Obtaining Constant Liquid Flow. William S. Gilfoil. Industrial & Engineering Chemistry, Analytical Edition, July 15, 1930, page 232.

An apparatus, easily constructed, for obtaining constant liquid flow is described and diagram given.—M. E. H.

The Measurement of a Rapidly Fluctuating Flow of Gas. Technical Paper No. 27, Department of Scientific and Industrial Research, 18 pages, price 6d.

This paper describes methods adopted at the English Fuel Research Station for measuring the flow of gas and air during experiments on the water-gas plant. The special difficulties met with were due to the rapid fluctuations in the flow, and the large volumes involved, while a further complication was introduced by the variation in the quality of the gas, which made it desirable to know not only the total volume of gas made, but to have a record of the rate of flow at any time. The average rate of flow measured in the apparatus described is some 300 cu. ft. min. but the actual rate varies from nothing to 500 or 600 cu. ft. min. The method adopted consisted in measuring the pressure drop across an orifice plate in a straight length of gas main, the pressure drop being recorded by photographing an inclined pressure gage.

POWER, WORK & OUTPUT

The Heat-Balance Test as a Means of Obtaining Evaporative Efficiencies of Steam-Generating Equipment. Paper No. FSP-52-33. B. J. Cross. Trans. A. S. M. E., Sept.-Dec., 1930, pages 255-264.

The efficiency of any energy-converting apparatus is determined by a division of the energy output by the energy input. In the case of boiler and furnace this is attained by weighing the coal or other fuel and weighing the water evaporated. The paper attempts to show that the efficiency as determined by the heat-balance method should have equal value with an efficiency as obtained by the test of weighing the coal and water. The author emphasizes throughout the importance of instruments and under each class of measurement specifies in detail the proper method of installation and of use. Example, under flue-gas temperature: "As in the sampling and analysis of gases, the possible error in the determination of temperature of the flue gases is due almost entirely to the location of the instrument used. The solution similarly is to use as many points as possible . . . In a breeching, for example, of 5 ft. by 15 ft., five couples may be located at 3-ft. intervals. Each couple may then be moved to five positions. There can thus be made 25 readings at as many points in the section . . . these 25 measurements can be made in not more than five minutes. A potentiometer should preferably be used . . ." Good and bad thermocouple welds are illustrated and discussed. Many interesting and novel points pertaining to measurements are brought out in the lengthy discussion following the paper.—M. F. B.

Aero-Engine Testing. "Aero." Electrical Review, Sept. 5, 1930, pages 371-372; Sept. 12, 1930, pages 411-413, Sept. 19, 1930, pages 452-453.

Describes electric power-plant employed with reference to layout, practical operation, economy, and other similar details.—M. S.

A Valve Clearance Indicator. Ferdinand Jehle. S. A. E. Journal, October, 1930, pages 473-474.

To predict how valve tappet clearance will vary as engine speed and load conditions vary is difficult; hence the necessity for this instrument, which is inserted in the place of a section of a valve push-rod which is cut away for this purpose. Reading instrument is fairly easy with engine running, since engine is its own stroboscope, the valve being on its seat twice as long as off. Image of scale is reflected on a screen and appears to stand still. Some results are discussed.—M. F. B.

The Engine Indicator as a Guide to Performance. H. A. Gehres, Cooper-Bessemer Monthly, September 1930, pages 3-5.

Ninth instalment of a series. This article covers reducing motions.—M. F. B.

A Simple Transmission Dynamometer. E. Giffen and C. M. White. Engineering, May 16, 1930, pages 621-625.

The instrument described is considerably shorter than the torsion-meter type. Its novelty does not lie in the principle of torque action but in its application. There are no delicate parts that are liable to give rise to mechanical trouble. This eliminates the need for any special care in handling, which makes the instrument suitable for workshop use. The dynamometer has been used for many months in the engineering laboratory of King's College, London, and has proved reliable and very satisfactory.—M. F. B.

INSPECTION & PRODUCTION

Optical Measuring Instruments as Practical Shop Tools. J. W. Marshall. Iron Age, Vol. 126, Nov. 13, 1930, pages 1372-1373.

Describes advantages of using an optical comparator as contrasted with mechanical gages in measuring screws poppet valves, dental burrs and many other products. Describes the Hartness comparator manufactured by the Jones & Lamson Machine Co.—V. S. P.

Constant Chord Gaging. American Machinist, Vol. 73, Aug. 7, 1930, pages 250-252.

Discussion by several men of an article of this title written by W. A. G. Chapman, published in American Machinist, V. 72, p. 753. See *Instruments*.—R. H. P.

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Gage for Indications of 1/1000 mm (Kleinmessmachine für Angabe von 1/1000 mm). Zeitschrift Feinmechanik und Präzision vol. 38, No. 22, Nov. 30, 1930, pages 3-4.

Feeler gage for crude adjustment from 0 to 150 mm for measuring cylindrical and plane pieces and threads, made by Carl Mahr G.m.b.H., Esslingen a.N., Germany.—Ha.

The Film as a Means of Technical Research (Der Film als Forschungsmittel der Technik). W. Ende. Forschung und Technik, 1930, pages 435-454.

To study in the minutest detail phenomena of motion in their space and time relation, cinematography has, in recent days, taken the foremost place as it permits the determination and fixing of both very slowly and very rapidly moving phenomena in all of their phases and stages. This is done by the slow-motion pictures with more than 25 exposures/sec., or by time magnification with less than 16 exposures/sec., which are reproduced later with the normal speed of 16 pictures/sec. In the first case, the actual occurrences appear slower; in the second, faster. The method of utilization of the film for the study of human work and its recording is described in detail and a few examples are discussed, such as the driving of a nail into a wooden block, and typewriting. Further, it is shown how very fast moving machinery and physical phenomena are recorded. The fundamentals of method and apparatus are discussed, described and illustrated by examples on (1) movement of fingers in typewriting, (2) collision of two heavy masses and (3) starting of an electric arc by the blowing of a fuse, taken by its own light. All of these studies have been made in the laboratories of the A. E. G., Berlin.—Ha.

Inspection of Spherical Surfaces. K. Takahashi. American Machinist, Vol. 73, Aug. 7, 1930, page 255.

Describes and illustrates a device for detecting irregularity in curved surfaces either concave or convex.—R. H. P.

Additional Uses for a Test Indicator. Walter Wells. American Machinist, Vol. 73, Aug. 14, 1930, page 294.

An indicator for measuring inside diameter of highly finished holes. Used only where limits of measurement were 0.001 in. or less. Consists of a caliper with one leg shortened and an ideal indicator attached to the stub leg.—R. H. P.

Inspecting with a Movie Camera. René Leonhardt. American Machinist, Vol. 73, Oct. 16, 1930, pages 613-616.

Detailed description and illustration of a camera recently developed in Germany for examining long bores. The image is placed on a continuous strip of motion picture films. The movement of the camera is held in proportion to the amount of film used to secure a good picture. The instrument is practically automatic and will stop itself in case of trouble or at the end of the pictures. —R. H. P.

Simplified Methods for Testing Cables and Pupin Coils at the Manufacturing Plant (Messvereinfachungen bei der Prüfung von Kabeln und Pupinspulen in den Lieferwerken). H. Reischel. A. E. G.-Mitteilungen No. 2 Feb. 1931, pages 42-48.

Describes a few measuring methods with DC and AC which simplify the work and time for checking the guarantee given by the manufacturer for telephone cables and induction coils.

Location of Defects with the Cathode-Oscillograph (Fehlerortsbestimmungen mit den Kathodenoszillographen). F. Roehrig. Elekt. Zsch. Vol. 52, No. 8, Feb. 19, 1931, pages 241-242.

Describes a new method to determine the location of faults, grounds, etc. in transmission lines or underground cables by means of surge-waves and cathode-oscillograph. The principle of the method consists in placing a line, open at both ends, suddenly under voltage, a surge wave is produced which wanders along the line and is reflected at the open end, with increase of voltage, but at a ground or short-circuit with reduction of voltage corresponding to the magnitude of the ground resistance. The oscillograph shows these voltage changes and offers therefor the means to locate and determine the size. This method can also be used while the lines are in service. The method is described and tests illustrated.

Gages Used in Mass Production in Germany. Industrial Gas, February 1931, pages 24-26.

Half the article discusses proper fits; the remainder deals only with gages suitable for measuring diameters of pieces while they are being ground.—M. F. B.

Wear Tolerances on Gages. Discussion of E. J. Bryant's Production Meeting Paper. S. A. E. Journal, February 1931, pages 210-214.

Included in the paper are recommendations for establishing wear tolerances as well as manufacturing tolerances for gages and definite periods for checking gages in service. Disposal of the manufacturing tolerance was discussed, and tables of tolerances recommended by the A. E. S. C. were presented. A study of effect of gage wear and methods of inspecting gages, presented by A. W. Shoof, leads discussion. Sharp disagreement with basis of the A. E. S. C. system of tolerances is expressed by representatives of leading auto mfrs. and a tabulation of tolerances is presented, based on standard reamer sizes adopted by both General Motors and Chrysler mfg. units. Warning is given by W. J. Gourlie, a gage mfr., against dangers that gage tolerances may either increase cost of producing work, because of making manufacturing tolerances smaller than intended, or allow work outside specified tolerances. A parts manufacturer called attention to gaging problems arising from distortion of work after measuring, because of releasing casting, forging or chucking strains. Author sees need of two classes of limit, one based upon standard shafts and one upon standard holes. He emphasizes fact that gages and tools are not an end but a means to an end. —M. F. B.

Production Testing of Present Day Radio Receivers. George G. Thomas. Electronics, February 1931, pages 498-499.

The author is in the engineering department of RCA Victor Company, Inc., and presents numerous valuable hints. It is interesting to learn that after the many tests described, a small percentage of each day's production of the receivers are thoroughly tested before shipment.—M. F. B.

Special Instruments for Radio Receiver Production Testing. Ralph P. Glover. Electronics, February, 1931, pages 500-501.

Discussed in detail are (1) a "limits" bridge—an adaptation of the Wheatstone bridge; (2) a visual oscillograph for testing component parts.—M. F. B.

Motor-Vehicle Maintenance to Prevent Road Delays. P. V. C. See. S. A. E. Journal, March, 1931, pages 353-364.

After outlining the organization of the companies he represents, the author discusses the factors governing layout and the procedure by which a fleet of 265 motorcoaches is maintained. Plans of the several garages are shown. A description is given of the report forms used in keeping records, the practice with regard to heavy overhauling is stated, and engine rebuilding is outlined in some detail. Several special instruments have been developed, among them a device for testing loose or worn bearings and a 150-HP dynamometer and related apparatus. 18 illustrations.—M. F. B.

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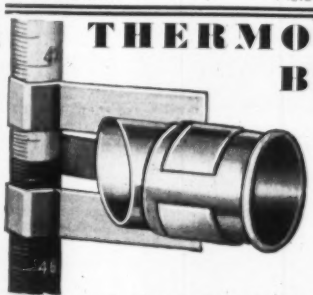

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LENGTH & AREA (INCL. SURVEYING)

An Optical Coincidence Gage. I. C. Gardner and F. A. Case. Bureau of Standards Journal of Research, Vol. 6, No. 2, (1931). Page 229.

A new type of optical instrument is described which enables one to make measurements in a direction normal to the surface viewed. Furthermore, the method of operation is sufficiently simple to permit its use for routine industrial measurements. The instrument is similar to a military range finder except that the two telescopes forming the optical system of the range finder are replaced by the two microscopes. In the instrument constructed at the National Bureau of Standards, the magnification is approximately 85 and, under favorable conditions, the probable error of a single reading is approximately ±0.001 mm (±0.00004 inch). As the settings are made without mechanical contact the instrument is particularly well adapted for measurements where all danger of deformation of the object should be avoided. It can also be used for making a measurement which terminates at an optical image, and this possibility has been realized in a second optical coincidence gage which was built for the purpose of adjusting the sound reproducing mechanism of a motion-picture projector.

The Accuracy of Length Measurements with a Vertical Tangent Screw (Ueber die Genauigkeit der Längenmessung mit einer vertikal wirksamen Tangentenschraube). Karl Luedemann. Allgemeine Vermessungsnachrichten vol. 43 No. 10, Mar. 11, 1931, pages 145-154.

A very exhaustive study of the accuracy of measurements of lengths in surveying made with a tangent screw, i. e. a screw which measures the tangents of horizontal or vertical angles, shows that errors greater than 0.25% can easily be avoided.—Ha.

Small Theodolites with Reading by Line-Microscopes (Kleine Theodolite mit Ablesung durch Strichmikroskope). Adolf Fennel. Zeitsch. für Vermessungswesen vol. 60, No. 1, Jan. 1, 1931, pages 12-16.

Instead of reading with vernier, the divisions are read in the ocular lens which is provided with lines which facilitate estimating to tenths of a division. The division circle of the theodolite is illuminated. The arrangement is described in detail, and it is claimed the work can be done much more easily and more quickly and is less fatiguing.—Ha.

Recent Surveying Rods for Direct Reading of the Level of Prints of Tarrain (Neuere Nivellierlatten zum Direkten Ablesen der Höhen von Gelände Punkten). Dankleff. Allegmeine Vermessungsnachrichten Vol. 43, No. 3, Jan. 21, 1931, pages 33-36.

The rod of 5 cm width has in the center a 3 cm wide removable part of 1 ½ in. length which can be extended above the height of the rod and is shifted until the visor line intersects with the desired number.—Ha.

The Equipment with Short Focus of the Aero-Topograph Co. (Die kurzbrenweitige Ausrüstung der Aerotopograph G.m.b.H.) Bildmessung und Luftbildwesen vol. 5 No. 4, Dec. 1930, pages 183-188.

Description of a universal equipment for making maps of small scale, devised by Prof. Dr. Ing. R Hugershoff, built by Gustav Heyde, Dresden. The differences in the level of the territory can be about 600 m for a flying height of 2000 m without noticeable distortions in the reproduction.—Ha.

Aero-Surveying 6000 m Above Sea Level (Luftbildvermessung in 6000 m Geländehöhe). Max J. Ungewitter. Allg. Vermessungsnachrichten vol. 42 No. 52, Dec. 24, pages 817-819.

Surveying for power companies was, on account of the inaccessibility of the country, possible only from the air. A short description is given of the used method, apparatus and photographic means during flights which had to be made at an average altitude of 6000 m, sometimes, however, at 8000 m.—Ha.

Aerial Surveying and Blueprinting. Will H. Mayes. The International Blue Printer, October, 1930, pages 12-13, 38-39.

Photographing vast areas in rapid flight brings new opportunities to blueprinters. Process is described, applications discussed, value of air maps set forth.—M. F. B.

Wear Allowances and Tolerances on Gages. E. J. Bryant. Metal Stampings. Oct. 1930, pages 895-896.

Paper presented before Society of Automotive Engineers. Small holes or tight work cause excessive wear. Dirty work affects gage life. High, hard finish obtained by mechanical lapping increases average life from 5000 to over 11000 holes before 0.0001 in. wear. General average for ordinary gagings per 0.0001 in. wear on new lapped gages. Soft spots cause excessive wear. It is more important that gages be uniformly hard than that they be excessively hard. Aluminum brass, and cast-iron are much harder on gages than soft steel. A small amount of light lubricant should be used on dry brass parts and those with a high percentage of copper. "Go" gages may be made larger than the minimum size hole usually by the amount that represents the production tolerance for the gages. Wear on "Not Go" gages is considerably less severe than on "Go" gages and no allowances for wear other than the gage maker's tolerance is provided on "Not Go" gages. Pressure in making measurements is important. Checking tools should check the point of wear in the gage.—M. S.

WEIGHT & DENSITY

Automatic Weighing of Poured Materials (Selbsttätiges Verwiegen von Schüttgütern) Fr. Prockat. Die Messtechnik Vol. 7, Feb. 1931, pages 33-37.

Description of types of scales for continuous automatic weighing of quantities of small materials during transportation on conveyors, elevators, etc. The accuracy is about ±1-2% for scales in connection with conveyors, while for scales with containers even ±0.2% can be obtained. Types built by C. Schenck, Schaffer, Polysius, Hennef are described.—Ha.

PHYSICAL TESTING

Oil-Testing Apparatus (Oelprüfapparat). F. Crotogino A. E. G. Mitteilungen Mar. 1931, page 163-164.

A cabinet on rolls containing a transformer for 16.5 KV/cm., oil container, and test electrodes.—Ha.

A Simple Method to Determine Tensile Stresses and Shape of Curve of any Type of Suspended Lines (Eine einfache Methode zu Bestimmung der Zugspannungen und Kurvenform beliegig aufgehaengter Freileitungen) Hugo Grob. Elekt. Zsch. Vol. 42, No. 7, Feb. 12, 1931, pages 209-210.

From the similarity of all catenary curves a new graphical method is developed which permits simply and quickly to determine the tensile stress at any point of the curve and the shape of the curve of a suspended wire or cable without much calculation. An example is given.—Ha.

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AN IMPACT STRAIN GAGE

DR. CLARENCE ALOIS ANDREE, INSTRUMENTS, Vol. 4, No. 5, May 1931, pages 265-275, 7 figs.

Design of gage is considered and construction is described.

NOTE ON JULIUS SUSPENSIONS

M. J. BREVOORT, INSTRUMENTS, Vol. 4, No. 5, May 1931, pages 277-278, 1 fig.

An improved form is described and illustrated.

TIMING AND SCHEDULING INSTRUMENTS

M. F. BÉHAR, INSTRUMENTS, Vol. 4, No. 5, May 1931, pages 279-285.

Indicators, recorders and controllers briefly discussed.

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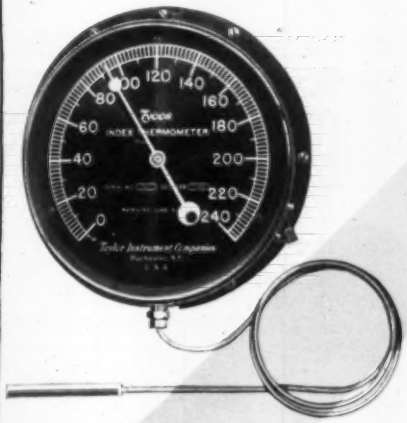

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